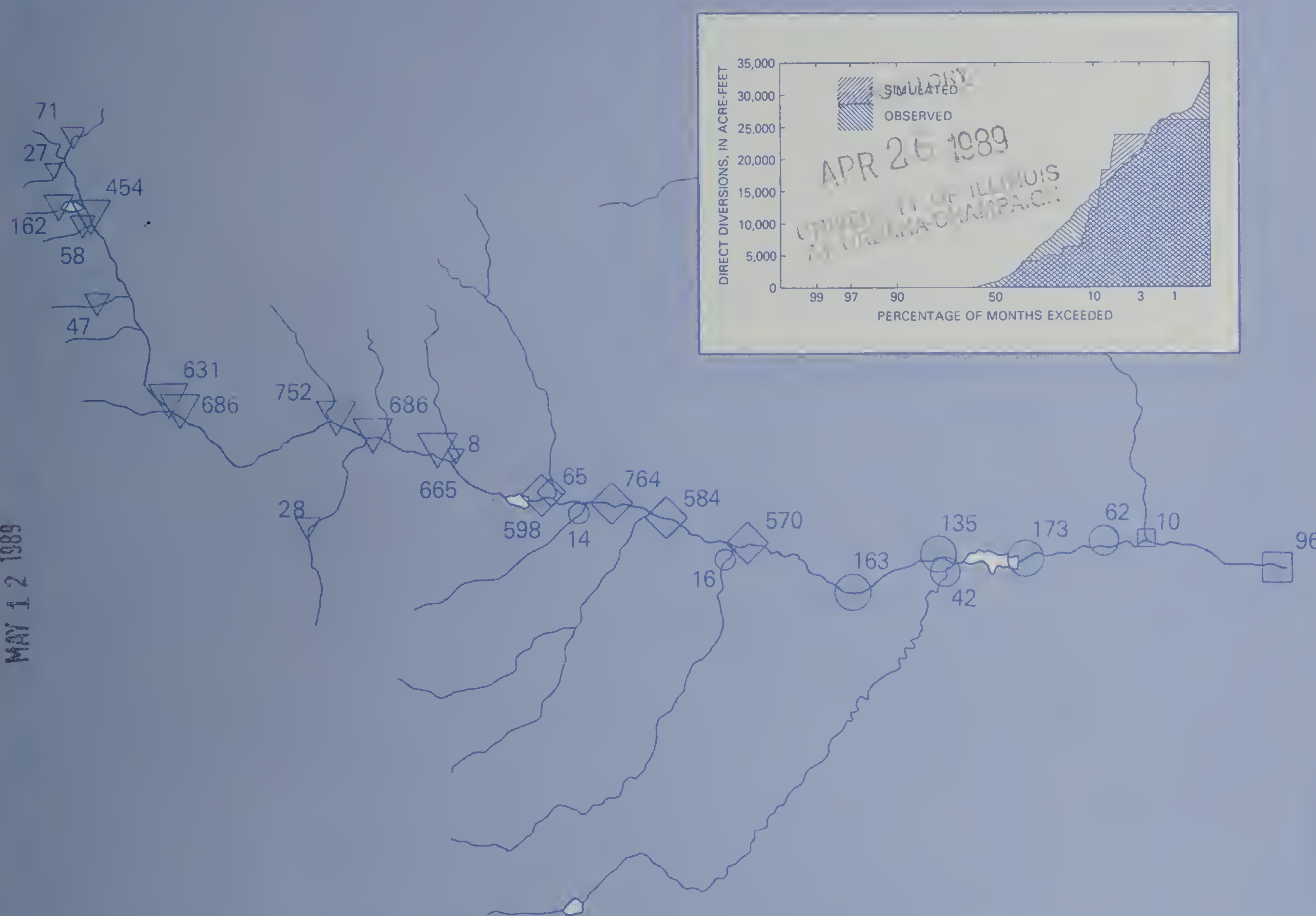
CALIBRATION AND USE OF AN INTERACTIVE-ACCOUNTING MODEL TO SIMULATE DISSOLVED SOLIDS, STREAMFLOW, AND WATER-SUPPLY OPERATIONS IN THE ARKANSAS RIVER BASIN, COLORADO

U.S. GEOLOGICAL SURVEY



Water-Resources Investigations Report 88-4214

Prepared in cooperation with the
SOUTHEASTERN COLORADO WATER CONSERVANCY DISTRICT

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Lakewood, Colorado
1989

DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

Inch-pound units in this report may be converted to metric (International System) units by using the following conversion factors:

Multiply	*By*	*To obtain*
acre-foot	1,233	cubic meter
cubic foot per second	0.02817	cubic meter per second
cubic foot per second per mile	0.0176	cubic meter per second per kilometer
ton, short	907.2	kilogram
inch	25.4	millimeter

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

An interactive-accounting model was used to simulate the dissolved solids, streamflow, and water-supply operations in the Arkansas River basin, Colorado. The model calculates streamflow for incremental drainage areas by use of regression equations and a time series of independent variables such as snowpack, precipitation, or gaged streamflow. Dissolved-solids concentrations can be calculated at each model node location for the corresponding streamflow. Streamflow and dissolved-solids loads then can be routed downstream by the model. Use of the model incorporating relations of specific conductance to streamflow enabled the computation of dissolved-solids loads throughout the basin. To simulate streamflow only, all of the water-supply operations were incorporated in the incremental streamflow regression relations and the model was calibrated for 1940-85. Coefficients of determination for streamflow-only simulation for 20 nodes ranged from 0.89 to 0.58. The model input was then revised to incorporate 74 water users and 11 reservoirs to simulate water-supply operations. Two periods were used for this calibration: 1943-74, which included John Martin Reservoir; and 1975-85, which also included the Fryingpan-Arkansas project with Pueblo Reservoir. Calibration of the water-supply operations resulted in coefficients of determination that ranged from 0.87 to negative for 37 selected water users. Even for those users whose simulated irrigation diversions did not relate well statistically to the observed diversions, plots of data generally indicated reasonable model results. Plots of simulated reservoir contents also indicated reasonable similarity to observed values. Coefficients of determination for 13 selected streamflow nodes ranged from 0.87 to 0.02. To demonstrate the utility of the model, six specific alternatives were simulated to consider the effects of the potential enlargement of Pueblo Reservoir. The model was used in this mode to simulate a 46-year period, which represented hydrologic conditions of 1940-85, with three major different alternatives: 1975-85 calibrated model data, calibrated model data with an addition of 30 cubic feet per second to the Fountain Creek flows, and calibrated model data with a municipal water user leaving Fryingpan-Arkansas project water in storage rather than diverting it. These three major alternatives included the option of reservoir enlargement or no enlargement to give the six total alternatives. A 40,000-acre-foot enlargement of Pueblo Reservoir resulted in average annual increases of 2,500 acre-feet in transmountain imports, of 800 acre-feet in storage diversions, and of 100 acre-feet in winter-water storage.

INTRODUCTION

The hydrologic system of the Arkansas River basin in Colorado is a set of complex interactions between surface water and ground water and between natural runoff and man's water use. Most of the streamflow in the river originates as snowmelt in the mountainous upper basin (fig. 1). The river is a conduit that transports the water eastward to the fertile lands of eastern Colorado. Irrigation in the basin began about 1860 with small ditches diverting water to irrigate the nearby flood plain. By the 1880's, large ditches had been constructed to irrigate thousands of acres along the river, and the normal streamflow that occurs during the growing season had been appropriated for use. To enable use of streamflow that occurred at times other than during the growing season, diversion canals leading to off-channel storage reservoirs were constructed during the 1890's. To supplement water supply for irrigation, water was imported from the Rio Grande and Colorado River basins as early as 1900; the water then was stored in high-mountain reservoirs for delivery during the growing season or during periods of lower natural streamflow. Many ground-water wells were drilled in the 1940's, 1950's, and 1960's in the alluvial aquifer adjacent to the river to supply additional water for irrigation. In addition to these privately financed developments, the Federal government built two large on-channel reservoirs for flood protection and supplemental irrigation water. John Martin Reservoir (capacity of 701,775 acre-feet) near Las Animas was completed by the U.S. Army Corps of Engineers in about 1947; Pueblo Reservoir (capacity of 357,000 acre-feet) near Pueblo was completed by the U.S. Bureau of Reclamation in about 1975. In addition, Trinidad Reservoir (capacity of 114,500 acre-feet) was built on the Purgatoire River near Trinidad by the U.S. Army Corps of Engineers about 1980.

The hydrologic cycle in this complex, conjunctive-use system can be idealized as follows. Good quality water exits the mountainous part of the basin as snowmelt (upstream from Canon City) in the late spring-early summer. This water is diverted for irrigation. Canal leakage and excess irrigation applications recharge the alluvial aquifer adjacent to the river. Because of the concentrating effects of consumptive use of water but not solutes by crops, this recharge is degraded from that of the applied water. Return flows, in the form of both surface water and ground water, replenish some of the flow in the river, which provides water to the next user downstream. This process continues on downstream, and streamflow generally decreases and solute concentrations increase. As the proportion of the river flow that was the original good quality snowmelt decreases downstream, the quality of surface water in the river and ground water in the adjacent aquifer becomes more similar. In areas of ground-water pumpage, return flows are diminished. However, the decrease in return flow because of pumpage is offset by return flows caused by additional excess irrigation applications produced by the added ground-water supply.

In a cooperative study between the Southeastern Colorado Water Conservancy District and the U.S. Geological Survey, an interactive accounting model for a digital computer was developed (Burns, 1988) to simulate the hydrologic system of the Arkansas River basin in Colorado. The model has many options capable of simulating varying degrees of complexity. In its simplest form, the model was used to simulate dissolved-solids loads throughout the basin by entering observed streamflow data at the node locations of interest (without using the routing capability of the model). The model then was used

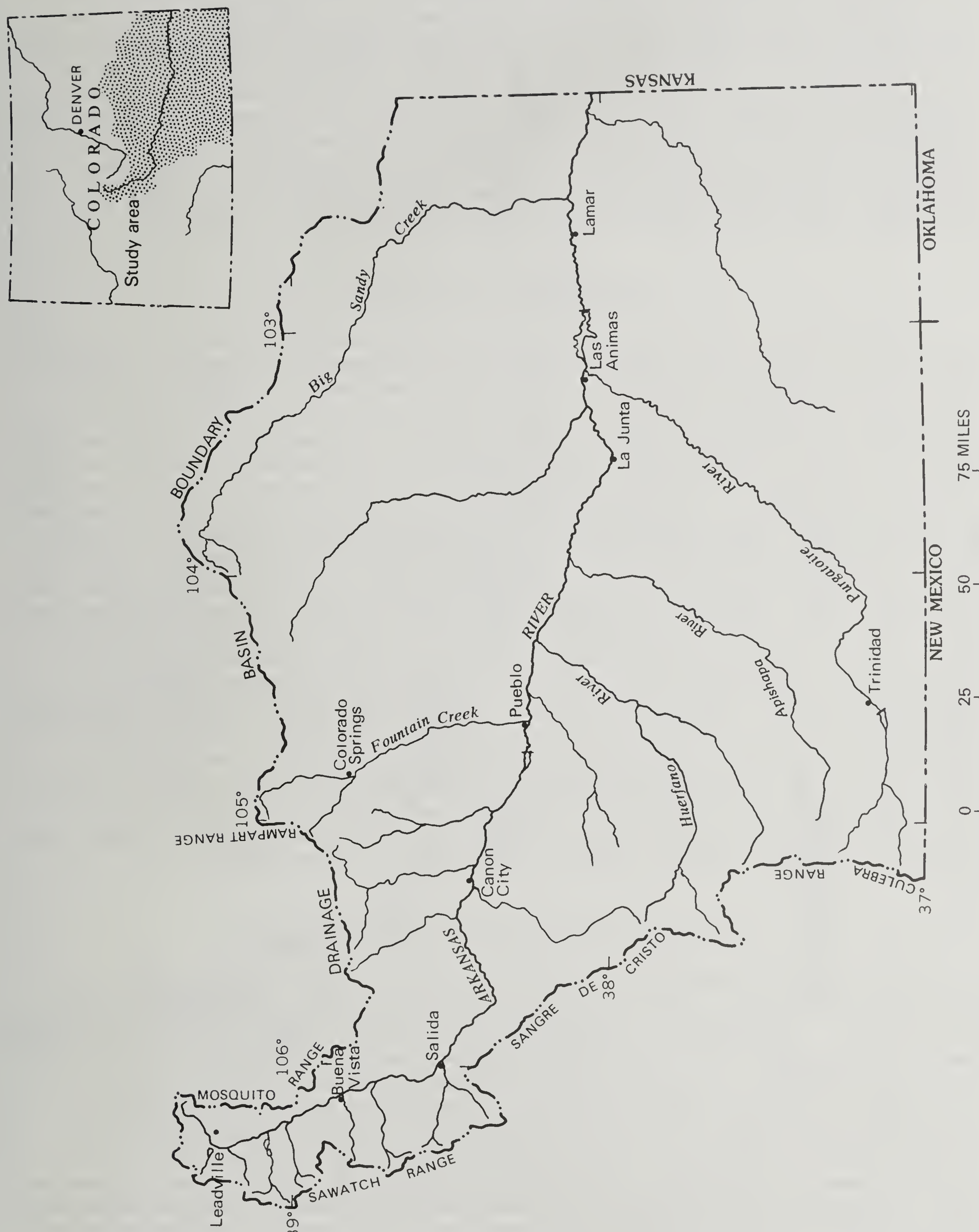

Figure 1.--Location of study area.

to simulate the hydrologic system of the basin by using regression equations to calculate incremental streamflow at each point of interest and by routing the streamflow and dissolved-solids loads downstream. For this simulation, the effects of water use were incorporated into the regression equations that normally calculate only incremental streamflow. Finally, the model was used to simulate the water-supply operations of the basin, including reservoirs, ground-water pumpage, and irrigation return flows. This report discusses the calibration and use of the model in the Arkansas River basin and the data necessary to simulate the basin at each level of complexity. The process of adjusting model parameters and factors so that the model will provide a reasonable and useful facsimile to the real system also is discussed.

Description of the Model

The Arkansas River and tributaries are represented in the model by a network of nodes (fig. 2). Node ID's (numbers) and names are listed in table 1 with the corresponding gaging-station numbers and names. Gaging stations 07137500 and 07137000 are located in Kansas but are used in the model to represent streamflow leaving the State of Colorado. Regression equations are used to estimate the monthly streamflow of each incremental drainage area, by using a time series of independent variables such as snowpack, precipitation, or gaged streamflow. Concentrations of a conservative constituent (dissolved solids for this study) are calculated by using regression equations; streamflow is the independent variable. Streamflow and dissolved-solids loads then are routed downstream. When all of the model options are used, the water-use and ground-water systems in the basin also are included. Types of water users that can be simulated include agricultural, municipal, and industrial users, and reservoir operators. Each water user has a list of potential water sources that includes direct diversions, ground-water pumpage, imports, or reservoir releases. Specific data are input to the computer in the order that the water user will use these sources to satisfy individual demands. All direct diversions are simulated to conform to the basinwide priorities, according to the prior-appropriation doctrine (Radosevich and others, 1975). Stream depletion from ground-water pumpage, and return flow from excess irrigation applications and canal leakage are simulated by using ground-water response functions (Jenkins, 1968a, 1968b, 1968c; Burns, 1983).

Purpose and Criteria of Model Calibration

The model was developed to simulate future or hypothetical changes in hydrologic conditions or water-supply operations in the Arkansas River basin in Colorado. Confidence in simulated results can be enhanced by demonstrating the reasonableness of the results. Hydrologic models, in general, have three typical components: (1) Model input, a time series of natural stresses; (2) model parameters, which enable equations in the model to describe the physical system being simulated; and (3) model output, a time series that results from the physical system acting on the natural stress inputs. A process common to hydrologic modeling is calibration, which is the process of entering an observed time series of input data to a model, and then adjusting the appropriate model parameters so that the time series of simulated output "best" fits, or matches, the corresponding observed sequence. "Best" fit can have many possible definitions that are qualitative and quantitative.

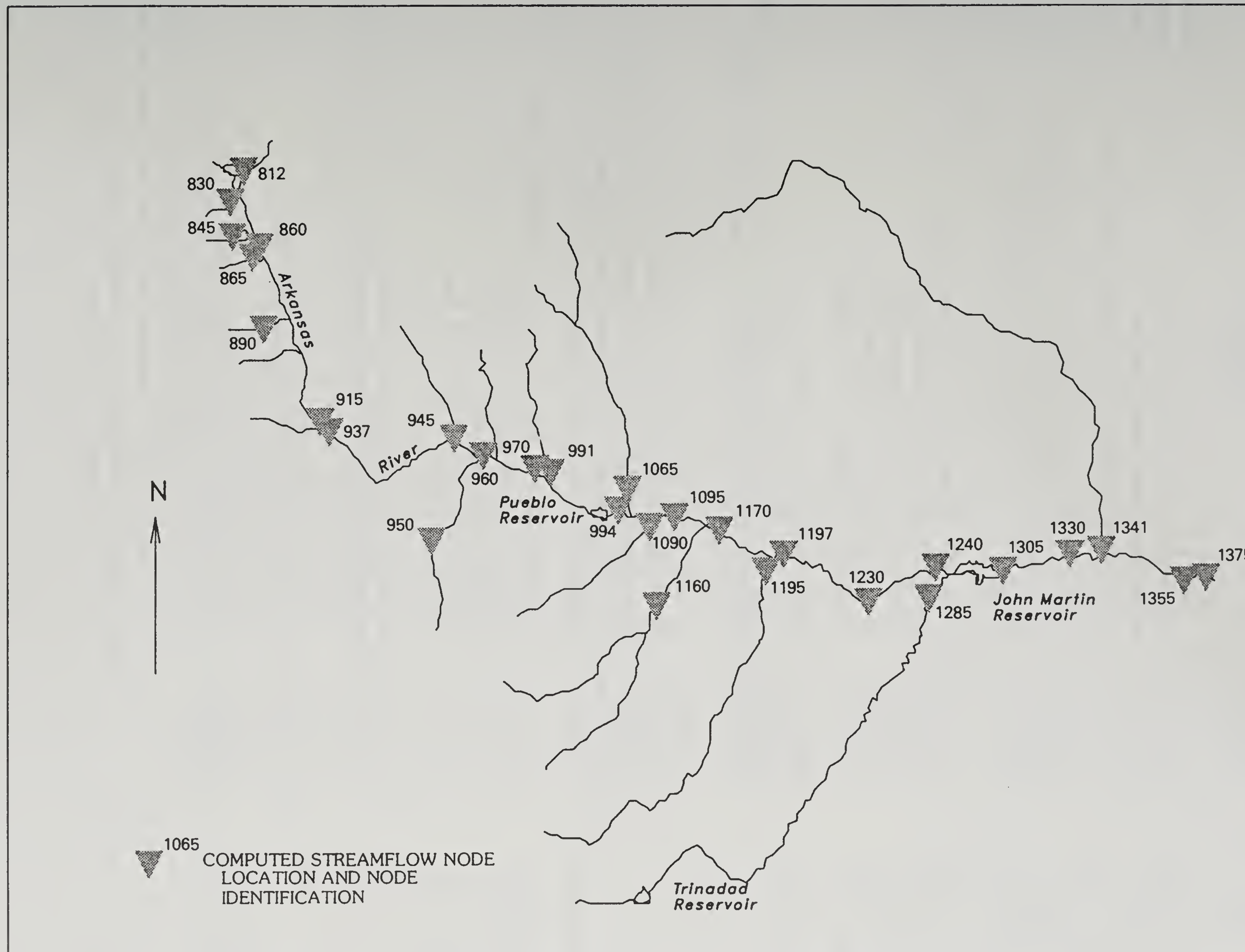

Figure 2.--Streamflow node locations in the Arkansas River basin model.

Table 1.--*Node locations in the Arkansas River basin model and corresponding streamflow-gaging stations*

Node ID	Node name	Station[1] number	Station name
812	ARK LEAD	07081200	Arkansas River near Leadville
830	HALFMOON	07083000	Halfmoon Creek near Malta
845	LAKE CK	07084500	Lake Creek above Twin Lakes Reservoir
860	ARK GRNT	07086000	Arkansas River at Granite
865	CLEAR CK	07086500	Clear Creek above Clear Creek Reservoir
890	COTTNWD	07089000	Cottonwood Creek below Hot Springs
915	ARK SLID	07091500	Arkansas River at Salida
937	ARK WELL	07093700	Arkansas River near Wellsville
945	ARK PARK	07094500	Arkansas River at Parkdale
950	GRAPE CK	07095000	Grape Creek near Westcliffe
960	ARK CANC	07096000	Arkansas River at Canon City
970	ARK PORT	07097000	Arkansas River at Portland
991	BEAVER C	07099100	Beaver Creek near Portland
994	ARK PUBL	07099400	Arkansas River above Pueblo
		07099500	Arkansas River near Pueblo
1065	FOUNT PB	07106500	Fountain Creek at Pueblo
1090	ST CHARL	07108500	St. Charles River near Pueblo
		07108800	St. Charles River near Vineland
		07108900	St. Charles River at Vineland
		07109000	St. Charles River at mouth near Pueblo
1095	ARK AVON	07109500	Arkansas River near Avondale
1160	HUERF R	07116000	Huerfano River below Huerfano Valley Dam
1170	ARK NPST	07117000	Arkansas River near Nepesta
1195	APISH R	07119500	Apishapa River near Fowler
1197	ARK CAT	07119700	Arkansas River at Catlin Dam
1230	ARK LAJU	07123000	Arkansas River at La Junta
1240	ARK ANMS	07124000	Arkansas River at Las Animas
1285	PURG ANS	07128500	Purgatoire River near Las Animas
1305	ARK JM R	07130500	Arkansas River below John Martin Reservoir
1330	ARK LAMR	07133000	Arkansas River at Lamar
1341	BIG SAND	07134100	Big Sandy Creek near Lamar
1355	ARK HOLY	07135500	Arkansas River at Holly
1375	ARK COOL	07137500	Arkansas River near Coolidge, Kansas
		07137000	Frontier Ditch near Coolidge, Kansas

[1]Station locations are identified in Burns, 1985, table 6 and plate 1.

For this model of the Arkansas River basin, no single measure of "best" fit is defined because of the multitude of simulated outputs produced. Various plots can be drawn to provide qualitative aids for judging reasonableness. Three statistics (mean of the residuals, standard deviation of the residuals, and coefficient of determination) can be calculated for many simulated results to provide a quantitative aid for judging reasonableness. Residuals are calculated as the differences between the simulated value for each month from the current simulation and the simulated value for the same month from some other simulation. During the calibration process, this "other" simulation would be observed data. The mean of the residuals (MR) is the arithmetic average, for all months, of the residuals; the standard deviation of the residuals (SDR) is the square root of the population variance of those residuals. Based on linear-regression theory, the best model parameters are those that produce the MR as zero and a minimized SDR. The coefficient of determination (R^2) for linear regression is defined as the amount of variation in a dependent variable that can be explained by relating it to an independent variable. The coefficient of determination adjusted for degrees of freedom may be expressed as:

$$R^2 = 1 - (SE^2/SD_y^2) \tag{1}$$

where SE = the standard error of estimate of the regression; and
SD_y = the standard deviation of the dependent variable.

For a simple linear-regression model, the SE would equal the SDR. Because the river-basin model is not a simple linear regression, the "best" fit may not have MR as zero. To account for this, the coefficient of determination, as used in this report, is defined to include the bias term of a possibly nonzero MR, as:

$$R^2 = 1 - \frac{(MR^2 + SDR^2)}{SD_y^2} \tag{2}$$

For those parameters calibrated by quantitative statistics, the criterion of maximizing R^2 normally was considered most important.

DATA AVAILABLE FOR MODEL INPUT AND CALIBRATION

Collation and analysis of the considerable data available required much of the effort necessary to develop the model for the Arkansas River basin. Observed streamflow data are essential to the model. During the simplest simulation of dissolved-solids loads, observed streamflow data are used as input at all selected main-stem nodes. During simulations that use more complex capabilities, observed streamflow at many of the tributaries is needed for input. Calibration of the model is evaluated by comparing simulated streamflow to observed streamflow. All the needed streamflow data are enumerated in the report "Selected hydrographs and statistical analyses characterizing the water resources of the Arkansas River basin, Colorado," by Alan W. Burns (1985). Precipitation and snowpack data, used as the time-series input of independent variables to the model, also are enumerated by Burns (1985).

Simple linear-regression coefficients are input to the model and used to calculate monthly streamflow from selected independent variables and to calculate dissolved-solids concentrations from streamflow. For the upper basin (upstream from Canon City), snowpack was determined to be the best independent variable to relate to May through September streamflow; precipitation was the best independent variable to relate to October through March streamflow; and air temperature was the best independent variable to relate to April streamflow (P.O. Abbott, U.S. Geological Survey, written commun., 1982). Abbott also determined that the same slope coefficient could be used at various locations, and that different intercept coefficients account for spatial differences in streamflow.

All the necessary regression coefficients for the calculation of dissolved-solids are presented in "Relations of specific conductance to streamflow and selected water-quality characteristics of the Arkansas River basin, Colorado," by Doug Cain (1987). Specific conductance is the most commonly available water-quality characteristic that is measured in the basin. The model first computes specific-conductance values with regression equations by using streamflow as the independent variable. Any conservative constituent that can be related to specific conductance then can be simulated with the model; however, the only constituent attempted to date (1989) is dissolved solids. Cain (1987) presents relations of specific conductance to dissolved solids and to six major ionic constituents. Cain (1987) also presents monthly time series of estimated dissolved-solids loads for three streamflow-gaging stations where at least 10 years of daily specific-conductance values are available for calculating those loads.

Simulation of the water-supply operations of the basin required qualitative and quantitative information. The general water-supply operations in the basin are described in "Description of water-systems operations in the Arkansas River basin, Colorado," by P.O. Abbott (1986). The water users, descriptions of their water systems, and selected data for their operations are enumerated by Abbott (1986); in addition, a listing of the basinwide water-right priorities as of 1985 is provided. Considerable additional data, such as monthly diversions, transmountain imports, reservoir-storage contents, and air temperatures, that were collated as part of this project from numerous sources, have been stored in a computer data base to enable easy retrieval and analysis (W.B. Blattner, U.S. Geological Survey, written commun., 1985).

MODEL CALIBRATION OF SIMULATED DISSOLVED SOLIDS

Cain (1987, table 4) presents regression coefficients for the relations of specific conductance to streamflow at 19 main-stem streamflow-gaging stations on the Arkansas River. Several forms of the relation were tested by Cain (1987); a log-log relation was determined to result in the best fit overall. Cain (1987, table 8) also presents the simple linear-regression coefficients that relate dissolved-solids concentration to specific conductance. These coefficients were calculated from regressions of instantaneous values. The model, in its simplest form, uses observed monthly mean streamflow for selected nodes. The dissolved-solids concentrations for each month simulated are calculated by using the given relations of specific conductance to streamflow and dissolved solids to specific conductance.

Even this simple use of the model required some parameter adjustment or calibration. Errors are introduced into the model because of the "cascading" regressions; that is, first calculating specific-conductance concentration, then dissolved-solids concentration, and then dissolved-solids load. Also, the calibration criteria of minimum MR and SDR for dissolved-solids loads are linear criteria; however, the use of log-log regressions does not produce minimized coefficients for use with arithmetic averages without certain adjustments (Ferguson, 1986). Because regression coefficients were determined from instantaneous values, errors may occur when monthly mean streamflow is used with those coefficients. To determine what adjustments, if any, would be needed to the regression coefficients, the model was used to simulate dissolved-solids loads for three nodes (994, ARK PUBL; 1305, ARK JM R; and 1375, ARK COOL) for which Cain (1987) calculated monthly dissolved-solids loads from daily specific conductance.

Coefficients for relations of specific conductance to streamflow for four simulations are listed in table 2. Separate relations were used for the summer season, May through September, and the winter season, October through April. The calculated MR, SDR, and R^2 for the dissolved-solids loads also are listed in table 2. For simulation 1, the regression coefficients are those calculated by Cain (1987) using instantaneous values. The statistics listed in table 2 relate the indicated simulation results to the observed monthly dissolved-solids loads (Cain, 1987, table 8) from calculated daily specific-conductance data. The coefficients of determination for simulation 1 were 0.65 for 994, ARK PUBL, 0.81 for 1305, ARK JM R, and 0.74 for 1375, ARK COOL. The observed values of dissolved-solids loads for streamflow-gaging station 07099400, Arkansas River above Pueblo, indicate a time trend (Cain, 1987, p. 73-75) that is not simulated by the model for node 994, ARK PUBL. Although the exact cause of this trend is not known, the impoundment of water in Pueblo Reservoir that began in 1974 is assumed to be the direct or indirect cause. Comparison of simulation 1 results for node 1305, ARK JM R,to observed values indicates a good seasonal fit with normally distributed random residuals of the peaks. The results of simulation 1 for node 1375, ARK COOL, indicate obvious overestimation of peaks compared with observed values (especially the flood of June 1965).

Study of daily specific-conductance and streamflow data, especially for June 1965 at streamflow-gaging station 07137500, Arkansas River near Coolidge, Kansas, indicates that coefficients determined from instantaneous data, but applied to monthly mean streamflow, may have caused much of the error indicated by these coefficients of determination. Therefore, log-log regressions were calculated by using observed values of monthly dissolved-solids load and monthly mean streamflow. Regression coefficients for the relations of specific conductance to streamflow that are calculated by log-log regression analysis are listed in table 2 (simulation 2). The generally improved coefficients of determination for the three nodes were 0.68 for 994, ARK PUBL, 0.80 for 1305, ARK JM R, and 0.83 for 1375, ARK COOL. Ferguson (1986) reports an adjustment that can be made to the intercept coefficient of a log-log regression to enable the relation to approximate an arithmetic-minimization criterion. The effects of adjusting the coefficients of the relations of specific conductance to streamflow (simulation 3) ranged from no change for node 994, ARK PUBL, and node 1305, ARK JM R, to a decrease to 0.79 for node 1375, ARK COOL.

Table 2.--*Statistical summary of simulated dissolved-solids loads*

[All load values are in tons per month]

	Observed data	Simulation number[1]			
		1	2	3	4
994, ARK PUBL					
Number of months.	204				
Average salt load.	12,700				
Standard deviation.	10,500				
Winter relation intercept.		3,000	1,810	1,850	2,180
Winter relation slope.		-0.32	-0.21	-0.21	-0.24
Summer relation intercept.		3,000	3,510	3,660	1,620
Summer relation slope.		-.32	-.33	-.33	-.22
Mean of the residual (MR).		-1,520	-240	273	-52
Standard deviation of the residual (SDR)---------		6,030	5,890	5,860	5,770
Coefficient of determination (R^2)-----		.65	.68	.68	.70
1305, ARK JM R					
Number of months.	360				
Average salt load.	27,300				
Standard deviation.	35,300				
Winter relation intercept.		4,100	3,940	4,100	3,770
Winter relation slope.		-.09	-.11	-.11	-.08
Summer relation intercept.		5,900	4,450	4,630	5,230
Summer relation slope.		-.21	-.17	-.17	-.19
Mean of the residual (MR).		184	-1,920	-702	4
Standard deviation of the residual (SDR)---------		15,600	15,900	15,800	15,500
Coefficient of determination (R^2)-----		.81	.80	.80	.81
1375, ARK COOL					
Number of months.	128				
Average salt load.	28,700				
Standard deviation.	48,800				
Winter relation intercept.		5,100	4,990	5,230	10,400
Winter relation slope.		-.06	-.11	-.11	-.24
Summer relation intercept.		6,900	4,570	4,780	10,200
Summer relation slope.		-.20	-.16	-.16	-.29
Mean of the residual (MR).		6,250	153	1,510	448
Standard deviation of the residual (SDR)---------		23,900	19,900	22,400	7,800
Coefficient of determination (R^2)-----		.74	.83	.79	.97

[1]Simulation 1 used regression coefficients calculated by Cain (1987) using instantaneous values. Simulation 2 used regression coefficients calculated using observed monthly dissolved-solids loads. Simulation 3 used regression coefficients calculated using the observed monthly dissolved-solids loads, adjusted to account for the log-log regression. Simulation 4 used the "best-fit" calibrated regression coefficients.

Finally, a trial-and-error method was attempted to select coefficients of the relation of specific conductance to streamflow. For a given slope coefficient, a near-zero MR could be obtained by adjusting the intercept coefficient. A new slope coefficient then was selected, and its respective intercept coefficient, which would result in a near-zero MR, was determined. By using this stepwise procedure, a function of SDR to slope coefficient was developed, and a "best" set of coefficients was determined. The final set of coefficients for the relation of specific conductance to streamflow (simulation 4) for the three nodes is listed in table 2. The coefficient of determination for node 994, ARK PUBL, was 0.70; for node 1305, ARK JM R, was 0.81; and for node 1375, ARK COOL, was 0.97. Comparisons of the dissolved-solids loads simulated by the model using the trial-and-error coefficients (simulation 4) to those dissolved-solids loads simulated by the model using the coefficients based on instantaneous data (simulation 1) indicated a slightly improved fit for node 994, ARK PUBL; no difference in the fit for node 1305, ARK JM R; and much improved fits for almost every peak for node 1375, ARK COOL. The basin-description file with all of the regression coefficients used in simulation 4 is provided as Attachment A in the "Supplemental Information" section at the back of this report.

The time trend in the observed data for node 994, ARK PUBL was an obvious cause of error for dissolved-solids load simulated by the model. This error is symptomatic of calibration difficulties that occurred during the study for the more complex simulations. Although the model uses a time series of independent variables that have changing (and potentially time-trending) values, the description of the basin is assumed static for a given simulation. Thus, although Cain (1987) shows significantly different (from a statistical viewpoint) regression coefficients for two different time periods, coefficients cannot be changed with time in the simulation model. The model could simulate one selected time series of independent variables by using one set of coefficients and a second time series of independent variables by using another set of coefficients, but it cannot simulate the integrated effects of that changeover in one simulation.

EXAMPLE USE OF SIMULATED DISSOLVED SOLIDS

Cain (1987) presented coefficients for the relations of specific conductance to streamflow and dissolved solids to specific conductance for most of the main-stem streamflow-gaging stations in the Arkansas River basin. Cain (1987) also presented regionalized equations for the basin to estimate the coefficients for sites where there were insufficient data for regression analysis. Although adjustments were made during calibration to the coefficients of the three node locations where observed monthly dissolved-solids loads could be calculated from daily specific-conductance data, the only node where those adjustments made obvious differences was node 1375, ARK COOL. Therefore, the regression coefficients determined by Cain (1987) were used at all model nodes, except node 1375, ARK COOL, where the calibrated values were used, and node 1330, ARK LAMR, midway between node 1305, ARK JM R, and node 1375, ARK COOL. The assigned coefficients for node 1330, ARK LAMR, were based on one-half the adjustments calculated for node 1375, ARK COOL. Dissolved-solids loads throughout the basin then were simulated by using these coefficients.

Dissolved-solids loads were simulated by using observed streamflow data only for each decade from 1940-79 (fig. 3). For each decade, dissolved-solids load increases downstream until just downstream from Pueblo. A decline of dissolved-solids load associated with irrigation diversions occurs until downstream from La Junta, where a large increase in dissolved-solids load results from irrigation-return flow and the inflow of the Purgatoire River. The decline in dissolved-solids load through Lamar is the result of irrigation diversions. The increase of dissolved-solids load along the final reach upstream from the State line is most likely the result of irrigation-return flow. Data indicate that dissolved-solids load seems to be decreasing with time (fig. 3). Burns (1985) indicated a statistically significant downward trend existed for most of the streamflow data east of Pueblo, and although these load data were not statistically tested, it was assumed that any trends in dissolved-solids load primarily result from streamflow declines.

To alleviate possible interpretation errors because different periods of record exist for observed streamflow, another simulation was made for 1940-85. Missing streamflow data were estimated, and dissolved-solids load was based on complete streamflow records for every main-stem node location. The average simulated streamflow, dissolved-solids concentration, and dissolved-solids load for 1940-85 are shown in figure 4. There is a large increase in the dissolved-solids load between just upstream from Pueblo to just downstream from Pueblo. The total load leaving the basin is only slightly greater than the load near Pueblo, although there are tremendous variations at various node locations along the main-stem reaches.

MODEL CALIBRATION OF SIMULATED STREAMFLOW

The model can be applied to simulate streamflow throughout the basin by using only regression equations. For this application of the model, the water-supply operations are not included explicitly, but the effects of water use are incorporated into the regression coefficients. The network of node location, where incremental streamflow is calculated, can be divided into three general groups: (1) The upper basin main-stem node locations and tributary node locations upstream from Canon City, where streamflow is dominated by snowmelt runoff; (2) the tributary node locations for the remaining basin, where streamflow is affected by thunderstorms and irrigation diversions and return flow; and (3) the main-stem node locations for the remaining basin, where streamflow is dominated by irrigation diversions.

Regression equations of monthly streamflow for main-stem and tributary streamflow-gaging stations in the upper basin (upstream from Canon City) were calculated by P.O. Abbott (U.S. Geological Survey, written commun., 1982) by using multiregression analysis to determine the best independent variables and regression coefficients. For that analysis, monthly streamflow, in cubic feet per second, for 11 streamflow-gaging stations was converted into runoff, in inches, and, where appropriate, adjusted to "native" flow by accounting for transbasin diversions and changes in reservoir storage. Temporal and spatial independent variables were included in the analysis, so the resultant relations could be used to calculate monthly runoff for any site in the upper basin. Results of Abbott's analysis determined that log-log regressions were

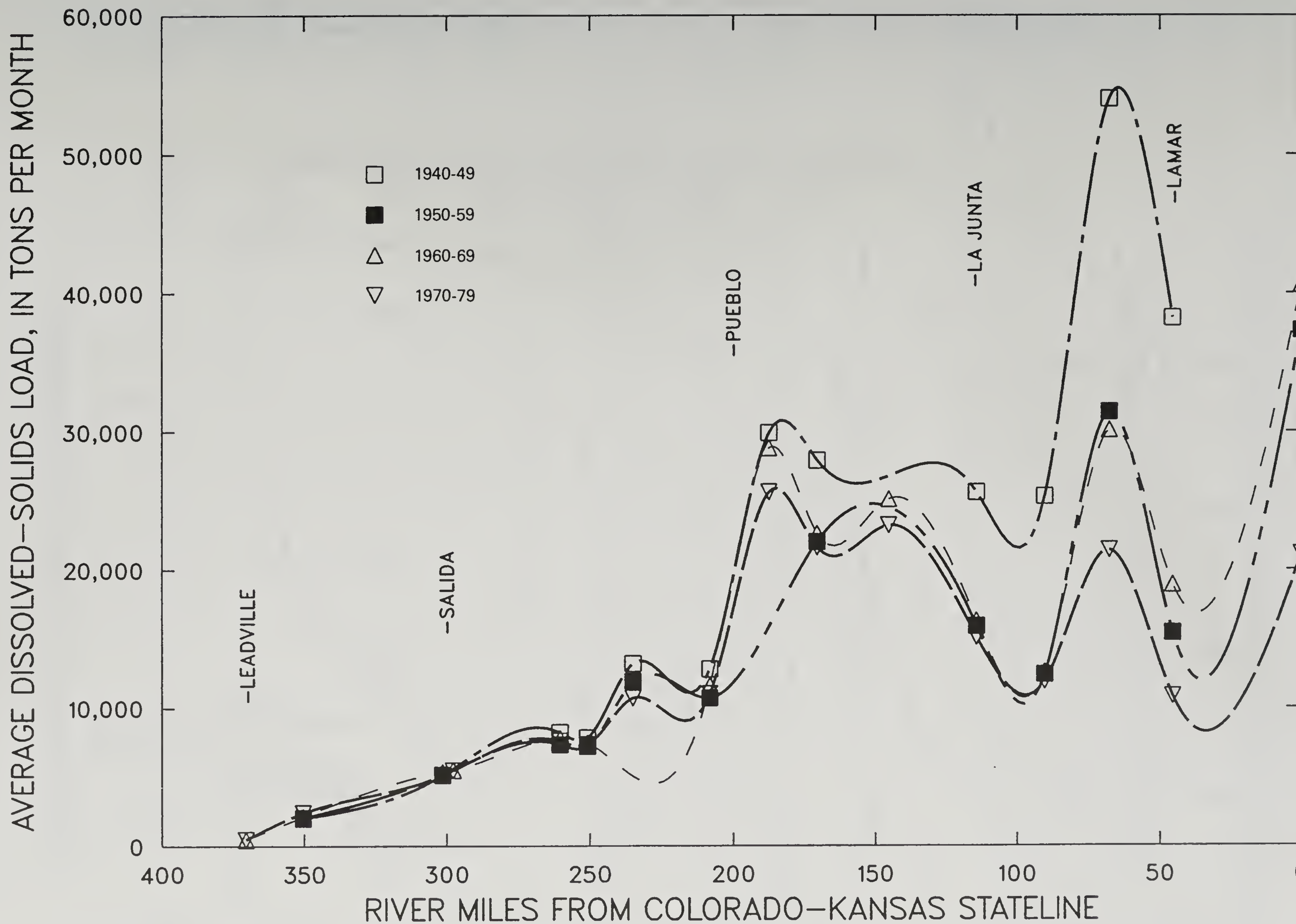

Figure 3.--Average dissolved-solids load, by decade, along the Arkansas River, 1940-79.

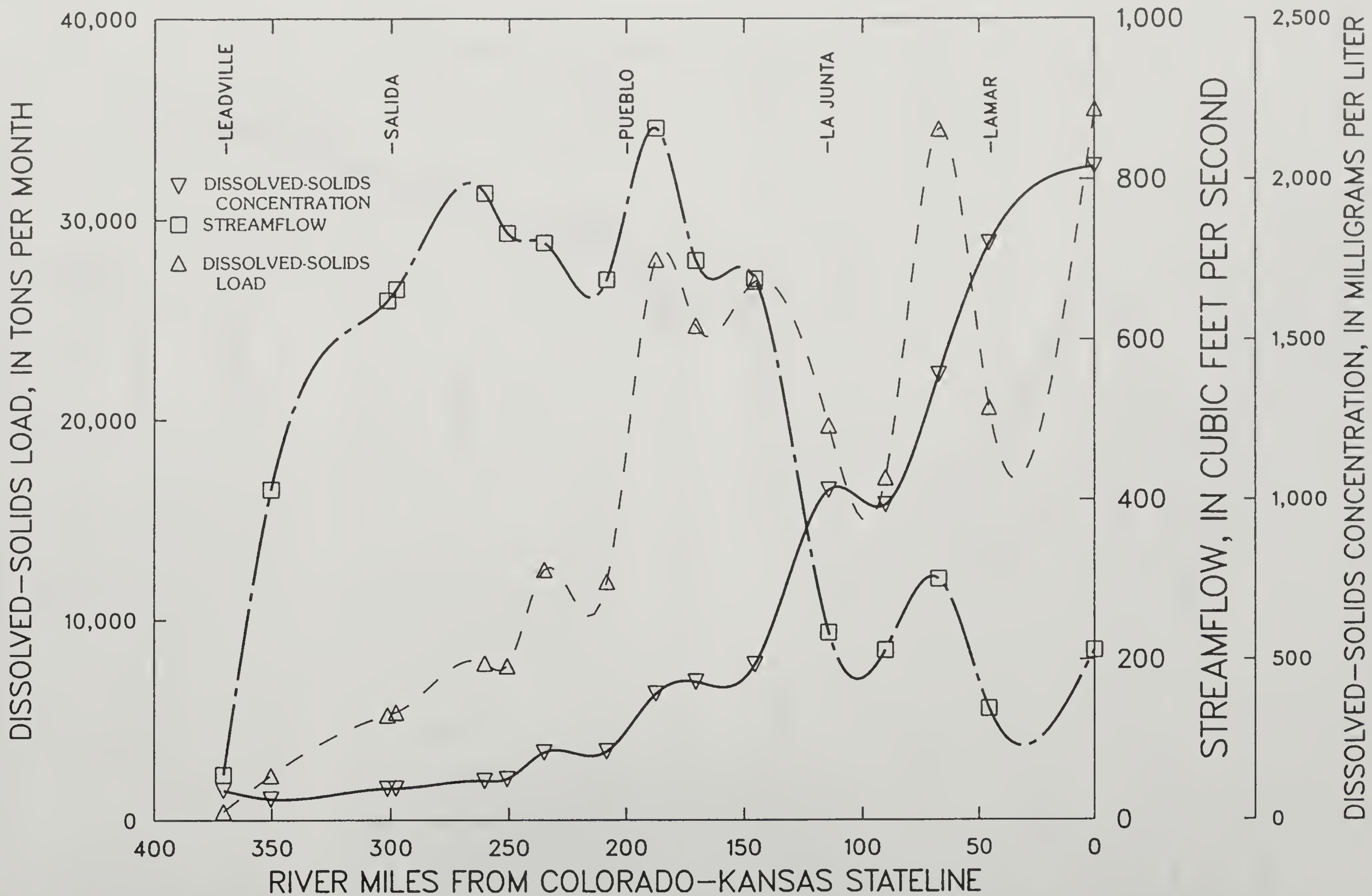

Figure 4.--Average simulated streamflow, dissolved-solids concentration, and dissolved-solids load along the Arkansas River, 1940-85.

best to estimate monthly runoff with: (1) A snow index [S], for May through September; (2) October precipitation data at Salida [P_{10}], for October through February; (3) March air-temperature data at Buena Vista [T_3] and October precipitation data at Salida [P_{10}], for March; and (4) April air-temperature data at Buena Vista [T_4], for April. The snow index [S] that provided the best fit of the data was a parameter that equally weighted the April 1 snowpack with the May 1 snowpack at the Park Cone and Independence Pass snow courses. Although this particular index gave the statistically best fit, other indices that use various combinations of the 2 months and the two sites indicated only minor variations in the goodness of fit, when the seasonal runoff (May through September) was regressed with the indices. The spatial independent variables that provided the best fit of the data were: (1) Percentage of the basin above 11,000 feet in elevation [A_{11}]; (2) percentage of the basin above 12,000 feet [A_{12}]; and (3) elevation of the streamflow-gaging station [E]. The regression model and coefficients are listed in table 3.

Table 3.--*Summary of multiple-regression analysis of streamflow upstream from Canon City*

[Model is $Q = aS^b T_3{}^c T_4{}^d P_{10}{}^e A_{11}{}^f A_{12}{}^g E^h$ where: Q is monthly runoff, in inches, for the indicated month; S is Park Cone April 1 and May 1 snow course measurements and Independence Pass April 1 and May 1 snow course measurements, snowpack water equivalent (inches); T_3 and T_4 are March and April measurements of air temperature at Buena Vista (degrees Fahrenheit); P_{10} is October precipitation at Salida (inches + 0.01 inch); A_{11} is ratio of drainage area above 11,000 feet to total drainage area; A_{12} is ratio of drainage area above 12,000 feet to total drainage area; and E is altitude of site where runoff is to be simulated (thousands of feet)]

Month	Regression coefficients								Coeffieient of determination, R^2
	a	b	c	d	e	f	g	h	
Season	1.330×10^{-2}	0.905	--	--	--	--	0.618	1.699	0.92
Oct.	1.888	--	--	--	0.050	0.968	--	-.468	.50
Nov.	3.909×10^{-2}	--	--	--	.044	.044	--	--	.27
Dec.	2.810	--	--	--	.011	.567	--	.968	.13
Jan.	2.196×10^{-1}	--	--	--	.019	--	--	--	.01
Feb.	1.833×10^{-1}	--	--	--	.012	--	--	--	.00
Mar.	7.220×10^{-2}	--	0.174	--	.009	--	--	.180	.01
Apr.	5.300×10^{-6}	--	--	2.145	--	--	--	1.386	.37
May	2.900×10^{-3}	.277	--	--	--	--	.268	2.538	.64
June	2.300×10^{-3}	1.051	--	--	--	--	.648	1.841	.88
July	1.700×10^{-3}	1.317	--	--	--	--	.789	1.278	.80
Aug.	1.840×10^{-2}	.683	--	--	--	--	.728	.937	.70
Sept.	3.190×10^{-2}	.452	--	--	--	--	.560	.778	.59

Several factors were considered to determine how to adapt the results of Abbott's analysis (U.S. Geological Survey, written commun., 1982) into the simulation model. The coefficients of determination for the snowmelt runoff months (May through September) ranged from fair to good (0.59 to 0.88). For simplicity in the model, only one snow course was used for the index, and, because of findings by Burns (1985) that in some years the May 1 snowpack is zero, the snow index selected was the April 1 snowpack at Independence Pass. For Abbott's analysis, the coefficients of determination for the winter months (October through March) ranged from poor to fair (0.00 to 0.50). Much of the poor fit was the result of rather small standard deviations of the observed data (see eq. 1). Although the regression coefficients result in estimates near the respective monthly means, not enough variation occurs about the mean to cause major error in the simulation. Based on that analysis, the independent variables selected for use in the model to simulate monthly incremental streamflow from October through March were monthly precipitation data at Twin Lakes Reservoir. April air-temperature data at Buena Vista was selected as the independent variable to simulate April runoff.

Each of the monthly slope-regression coefficients calculated by P.O. Abbott (U.S. Geological Survey, written commun., 1982) was used directly in the model input. The intercept coefficients to the regression relations were determined by trial and error within the model rather than using Abbott's values because: (1) The period of record used by Abbott generally was different from the period simulated in the model; (2) the model simulates streamflow that is intended to represent gaged streamflow, and not "native" flow; (3) the model nodes are at known gaged sites and, thus, there is no need to estimate data at ungaged sites; and (4) an arithmetic-minimization criterion was selected, whereas Abbott's analysis used a log-log minimization criterion. By adjusting the intercept coefficient at each node for each month, simulated streamflow resulted in an MR that approached zero for each month.

Fitting streamflow of tributaries in the lower basin downstream from Canon City by using regression generally was unsuccessful. Burns (1985) indicated that generally poor correlation occurred between monthly precipitation and streamflow in the basin. Although some relation must exist between rainfall and runoff in the central and eastern parts of the basin, to describe a useful relation most likely would require precipitation records from the individual drainage basins and time periods much shorter than a month. Because of these limitations, observed streamflow at the simulated tributaries is input directly to the model. For sites that did not have sufficient length of record, simple linear regression was used to fill in missing data, by using an upstream or nearby gaged streamflow record as the independent variable.

Fitting incremental main-stem streamflow in the lower basin downstream from Canon City was complicated because the typical independent variables gave poor results. Incremental streamflow is defined as the difference between downstream outflow and upstream inflow in a reach. For most of the streamflow-gaging stations on the Arkansas River downstream from Canon City, that difference usually is negative because of irrigation diversions. Regression analysis to fit the incremental streamflow was attempted by using precipitation, snowpack, and air-temperature data as independent variables. Streamflow in the river is substantially affected by diversions, which are governed by a fixed set of water rights. Therefore, regression relations that use time-varying independent variables usually resulted in statistically poor results.

After considering this factor, an additional independent variable was used in the analysis--upstream streamflow. In general, the greater the upstream streamflow is, the greater the diversion is. Thus, this variable often was the best independent variable. Another complicating factor in this regression analysis was that the best type of relation seemed to be a log-log type; however, some of the data often had both positive and negative values, which prohibits the use of log transforms. The final regression relations and corresponding coefficients were selected in a best-fit trial-and-error analysis. For each streamflow-gaging station, for each month, incremental streamflow was regressed with: (1) Precipitation data from the nearest upstream and downstream weather stations; (2) snowpack data from the two nearest snow courses; (3) air-temperature data from the nearest weather station; and (4) upstream streamflow data. For each station, simple linear regressions were calculated by using each of these independent variables; if all except 1 year of the calculated incremental streamflow were the same sign (positive or negative), each of the regressions also was calculated for the log-log transform of the data. The regression analysis that had the greatest coefficient of determination then was selected for that particular gaging station and month. When a log-log relation was selected, the slope coefficient was used directly, but the intercept coefficient was adjusted in the model by trial and error to determine the value that resulted in an MR of near zero by using the arithmetic average criterion.

To use the model, two data input files are necessary: (1) The basin-description file, which includes the node locations, network configuration, and monthly regression relations and coefficients; and (2) the time series of independent variables. The basin-description file is provided as Attachment B in the "Supplemental Information" section at the back of this report.

The time series of independent variables included data for 46 years (1940-85) for the 28 variables listed in table 4. Missing data for any of these variables were approximated by filling in with the monthly average value, or by regressing the data using data from a nearby site, as indicated in table 4. The statistical summaries of the simulated results are listed in table 5 for the simulated nodes in the model as mean of residuals (MR), standard deviation of residuals (SDR), and coefficient of determination (R^2). The mean and standard deviation of the observed data also are listed for comparative purposes. Based on the coefficients of determination, simulated results are very good ($R^2 > 0.80$) for 16 of the 20 simulated nodes in table 5. The best fit is 0.89 at node 812, ARK LEAD, and node 970, ARK PORT; the worst fit is 0.58 at node 1305, ARK JM R.

Burns (1985) indicated that much of the variation about the annual mean flow could be explained by seasonal patterns, especially in the upper basin upstream from Pueblo. Another simulation was made by using the mean monthly values of incremental streamflow for each node for each month to determine how much improvement had been affected by using regression analysis rather than using only the monthly mean. In effect, this new simulation uses only the intercept coefficient and sets the slope coefficient to zero. The SDR and R^2 values for this zero-slope-coefficient simulation are included in table 5. The inclusion of a slope coefficient indicates a reasonably good fit exists between simulated and observed streamflow throughout the basin; whereas, use of the zero-slope-coefficient simulation generally results in an R^2 decrease downstream. The observed and simulated streamflow from these two simulations

Table 4.--*Sites with time series of data that are used as input to the model*

Sites[1] with time series of data	Percent of 1940-85 record missing	Method of estimating any missing data
		Precipitation stations
1071 Buena Vista	11	regressed with 5990 North Lake
1294 Canon City	3	regressed with 8931 Westcliffe
3079 Fowler	11	regressed with 6131 Ordway
4076 Holly	8	regressed with 2446 Eads
4770 Lamar	<1	used monthly averages
4834 Las Animas	2	regressed with 4388 John Martin Dam
6740 Pueblo	16	merged 6741 Pueblo
	<1	then used monthly averages
7167 Rocky Ford	1	regressed with 4720 La Junta
7370 Salida	26	regressed with 8931 Westcliffe
8501 Twin Lakes Reservoir.	26	regressed with 5990 North Lake
		Snow courses
6K07 Four Mile Park	<1	used monthly averages
6L08 Garfield	33	regressed with 6K03S Twin Lakes Tunnel
6K04 Independence Pass	0	
5M1M La Veta	0	
		Streamflow-gaging stations
095000 Grape Creek	2	regressed with 099500 Arkansas River near Pueblo
099100 Beaver Creek	76	regressed with 117000 Arkansas River near Nepesta
		Streamflow-gaging stations--Continued
106500 Fountain Creek	14	regressed with 105800 Fountain Creek at Security
	2	then regressed with 106000 Fountain
108800 St. Charles River.	86	merged 108500 St. Charles River near Pueblo
	59	then merged 108900 St. Charles River at Vineland
	43	then regressed with 119500 Apishipa River near Fowler.
116000 Huerfano River	40	regressed with 123000 Arkansas River at La Junta
119500 Apishipa River	0	
128500 Purgatoire River	19	regressed with 126500 Purgatoire River at Ninemile
134100 Big Sandy Creek	68	regressed with 126500 Purgatoire River at Ninemile
		Air temperature stations
1071 Buena Vista	12	regressed with 8931 Westcliffe
1294 Canon City	5	regressed with 8931 Westcliffe
4770 Lamar	0	
4834 La Animas	4	regressed with 5018 Limon
6740 Pueblo	0	
7167 Rocky Ford	0	

[1]Site locations are identified in Burns (1985, tables 1, 3, and 6 and plate 1).

Table 5.--*Statistics for node locations used in the streamflow-only simulation*

[All flow values are in cubic feet per second]

Node[1] ID	Node name	Observed 1940-85 flow[2]		Simulation results using calibration coefficients			Simulation results using zero-slope coefficients	
		Mean	Standard deviation	Mean of the residuals (MR)	Standard deviation of the residuals (SDR)	Coefficient of determination (R^2)	Standard deviation of the residuals (SDR)	Coefficient of determination (R^2)
0812	ARK LEAD	72.3	109.	0.4	36.8	0.89	50.7	0.78
0830	HALFMOON	28.8	41.6	.1	14.3	.88	18.9	.79
0845	LAKE CK	166.	272.	.4	96.9	.87	109.	.84
0860	ARK GRNT	413.	446.	-.0	170.	.85	211.	.78
0865	CLEAR CK	68.3	97.4	.1	37.7	.85	47.7	.76
0890	COTTNWD	52.4	54.1	.1	22.1	.83	29.2	.71
0915	ARK SLID	644.	639.	.0	245.	.85	329.	.73
0937	ARK WELL	731.	665.	.4	245.	.86	360.	.71
0945	ARK PARK	806.	742.	-.0	300.	.84	396.	.72
0960	ARK CANC	733.	748.	-.2	297.	.84	409.	.70
0970	ARK PORT	775.	826.	.1	277.	.89	442.	.71
0994	ARK PUBL	675.	767.	.1	316.	.83	445.	.66
1095	ARK AVON	914.	870.	.0	321.	.86	432.	.75
1170	ARK NPST	699.	763.	.0	286.	.86	396.	.73
1197	ARK CAT	689.	687.	.0	261.	.86	348.	.74
1230	ARK LAJU	234.	483.	.4	253.	.73	264.	.70
1240	ARK ANMS	212.	462.	.3	248.	.71	252.	.70
1305	ARK JM R	302.	545.	-.1	353.	.58	448.	.32
1330	ARK LAMR	147.	446.	.3	240.	.71	337.	.43
1375	ARK COOL	197.	438.	.1	180.	.83	344.	.38

[1]See table 1 and figure 2 for node descriptions and locations.
[2]Not all stations had record for the entire period.

are shown in figures 5, 6, and 7; the observed streamflow (*A*), streamflow simulated using the zero-slope coefficients (*B*), and the streamflow simulated using calibration coefficients (*C*) for three selected nodes along the river are shown for 1940-85 [node 860, ARK GRNT (fig. 5); node 994, ARK PUBL (fig. 6); and node 1375, ARK COOL (fig. 7)]. When the zero-slope-coefficient simulation is used, the calculated incremental streamflow at each node is the same for each respective month, which gives a uniform response such as shown in figure 5*B*. However, the simulated streamflow at all of the nodes does not remain uniform, because the simulation includes the observed tributary inflows for all nodes downstream from Canon City. Therefore, the integrated effect of tributary inflow along the basin is readily seen in figure 7*B*.

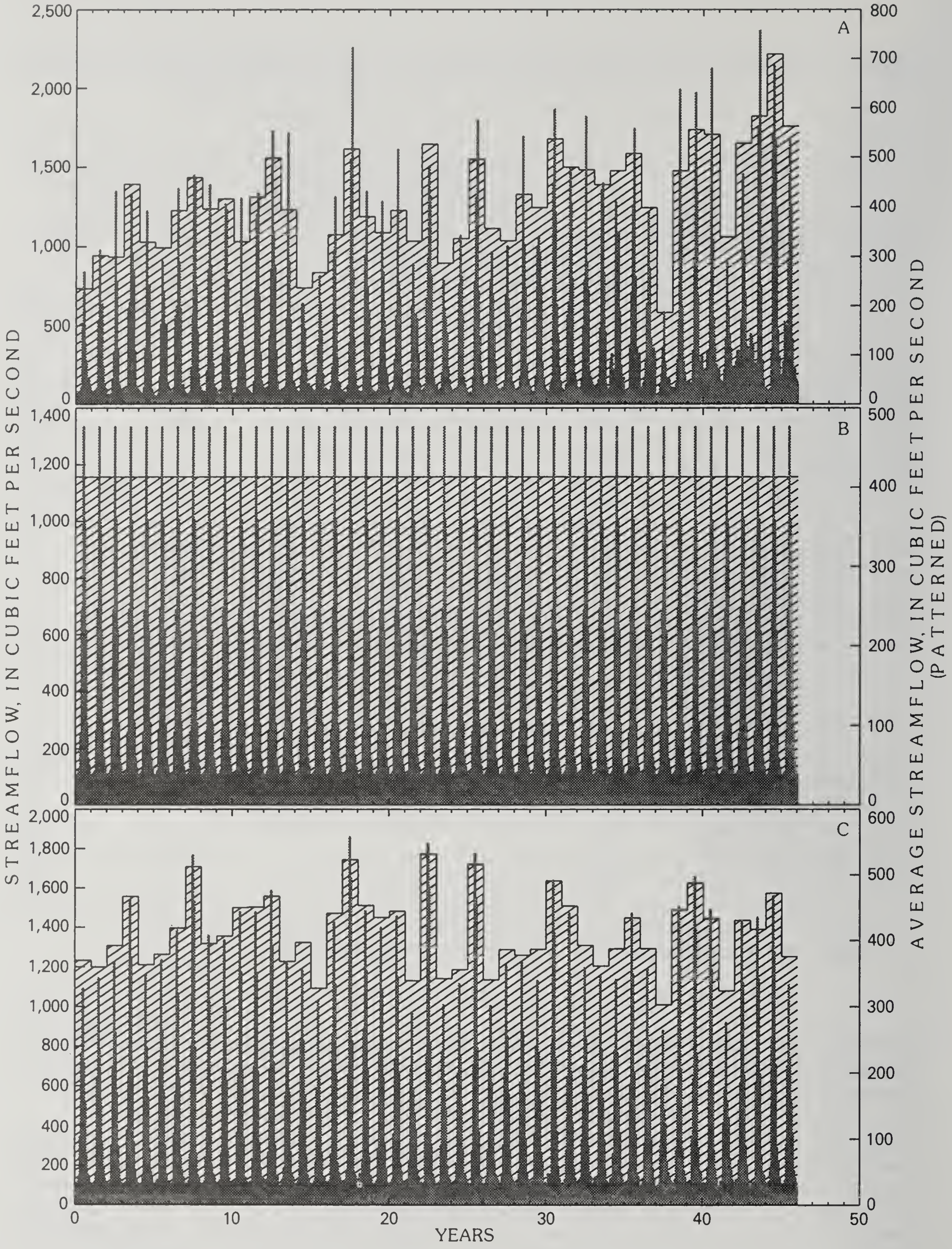

Figure 5.--Streamflow for node 860, ARK GRNT, 1940-85: *A*, Computed streamflow; *B*, Simulated streamflow using zero-slope coefficients; and *C*, Simulated streamflow using streamflow-only calibrated coefficients.

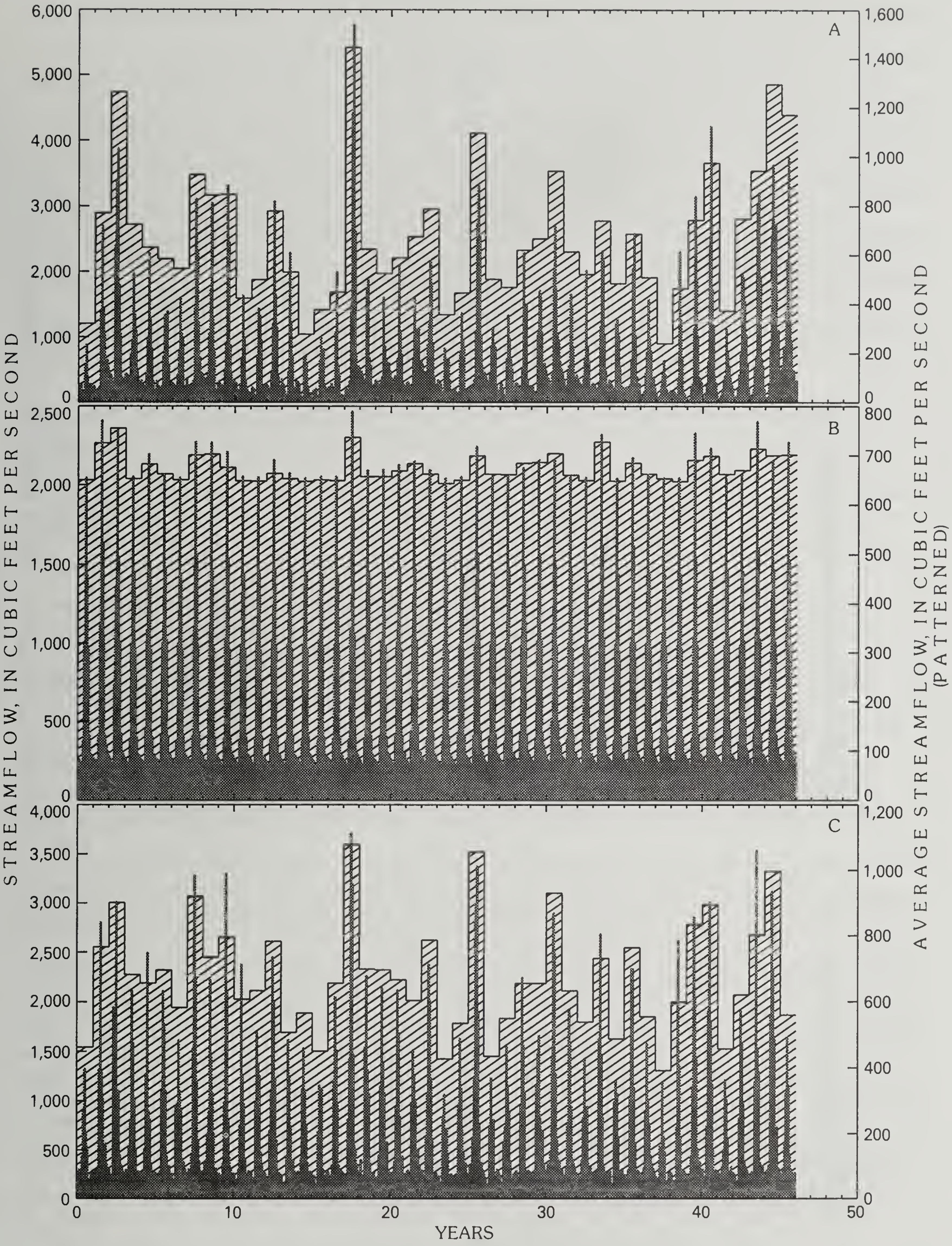

Figure 6.--Streamflow for node 994, ARK PUBL, 1940-85: *A*, observed streamflow; *B*, simulated streamflow using zero-slope coefficients; and *C*, simulated streamflow using streamflow-only calibrated coefficients.

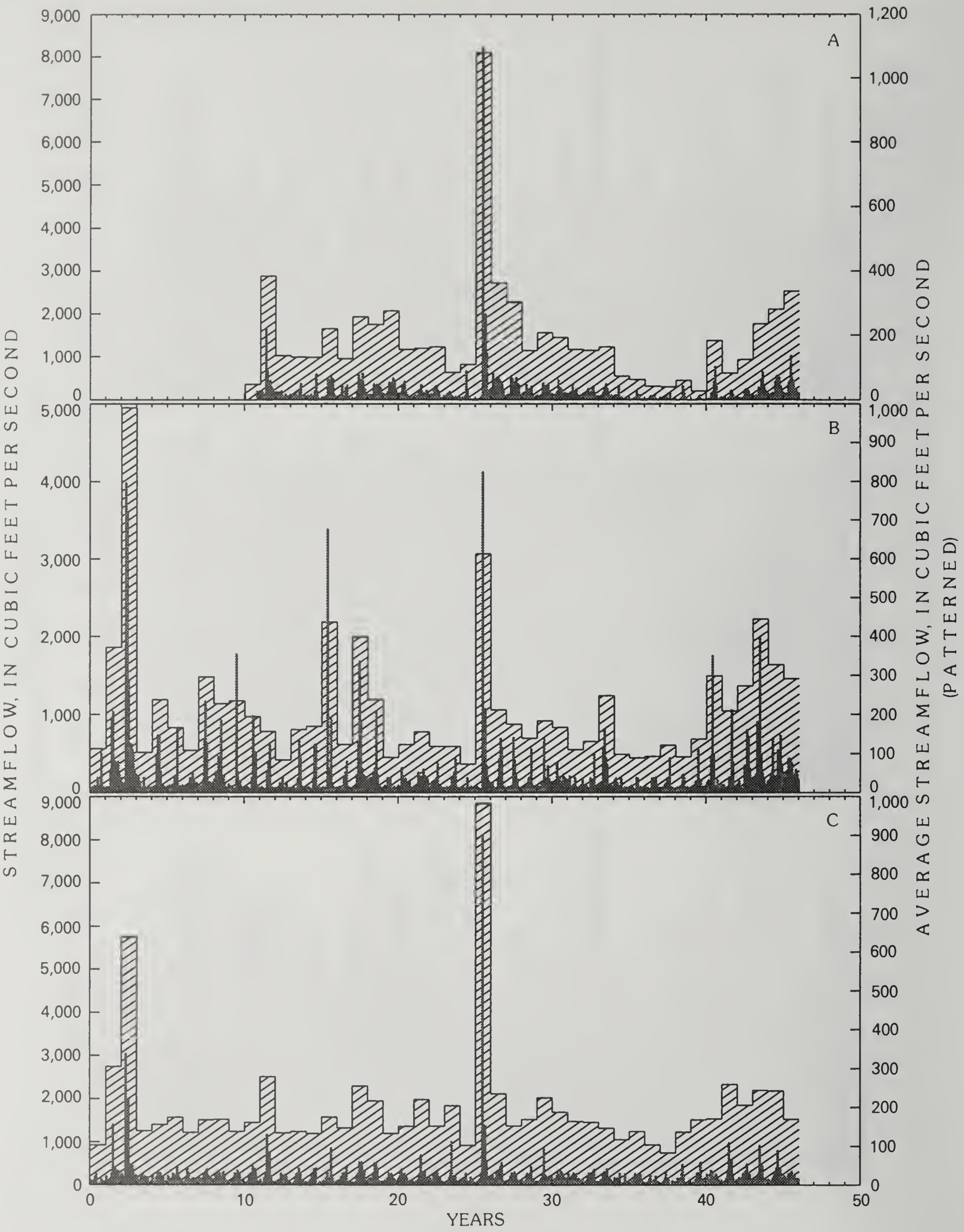

Figure 7.--Streamflow for node 1375, ARK COOL, 1940-85: *A*, observed streamflow; *B*, simulated streamflow using zero-slope coefficients; and *C*, simulated streamflow using stream-flow-only calibrated coefficients.

MODEL CALIBRATION OF SIMULATED WATER-SUPPLY OPERATIONS

The model, with all its options, simulates most of the hydrologic system in the basin: Natural runoff for all incremental areas; water diverted for irrigation and storage; pumpage of ground water; return flow; and stream depletions or accretions from ground water. The model calculates incremental streamflow at all node locations to produce a "prediversion" streamflow condition--the water that would be in the river if no diversions were made and if no on-channel reservoir storage occurred. To calculate this prediversion streamflow condition, a set of coefficients for each month and node are needed to compute the incremental streamflow. Although the calibrated values for these coefficients can be determined only through trial-and-error adjustments, the initial estimates are physically based.

For the main-stem and tributary nodes in the upper basin (upstream from Canon City), the streamflow-only calibrated coefficients are good initial estimates. Those coefficients generally simulated the snowmelt-runoff process. Adjustments to these previous coefficients are required because of possible transbasin imports, reservoir releases, irrigation diversions, and return flows that occur in the upper basin. The slope coefficients used in the streamflow-only calibration were maintained; only the intercept coefficients were adjusted during calibration.

Initial estimates of coefficients for the main-stem node locations downstream from Canon City were based on two parameters. The intercept coefficient of each monthly relation was calculated from estimates of phreatophyte evapotranspiration in a reach. Use of this parameter enables the model to account for losses from phreatophyte evapotranspiration. Estimates of phreatophyte acreages for reaches along the Arkansas River between Pueblo and the Colorado-Kansas State line and phreatophyte consumptive-use rates (Bittinger and Stringham, 1963) were used to determine the intercept coefficients. Thus, all the intercept coefficients used for the growing season initially were negative to simulate consumptive use by phreatophytes.

The slope coefficient of each monthly incremental streamflow relation was calculated by initially setting the slope to zero and operating the model to determine the average error of the streamflow for each particular node for each month. In this manner, simulated diversions and return flows were considered, and the difference between simulated and observed streamflow was assumed to be the incremental inflow. Monthly precipitaton at the nearest weather station then was selected as the independent variable to be used to calculate the incremental streamflow. The MR of the streamflow simulated by using this zero-slope coefficient was divided by the mean precipitation for each respective month to determine the slope coefficient. This procedure was repeated for each node location, moving downstream. Determination of the best calibrated values for these regression coefficients is complicated by the fact that the volume of the diversion (and thus, the volume of return flow) is a function of flow in the river. An additional complication occurred during some months when very large observed streamflow occurred during months with ordinary precipitation. To simulate these peak streamflows, some of the monthly relations had to be changed from linear to log-log. Because the negative intercept coefficients could not be used with the log transform, the intercepts also were changed in those months. The basin-description file for calibration, which was determined as just described, is provided as Attachment C in the "Supplemental Information" section at the back of this report.

Additional information describing the river basin hydrologic system, which is related to the water-supply operations, also is needed. Several water-consumption parameters are needed, including: (1) Monthly crop potential-evapotranspiration rate; (2) monthly lake-evaporation rate; (3) monthly irrigation-diversion demand rate; and (4) a municipal- and industrial-demand rate. Initial estimates for the rate of monthly crop potential evapotranspiration and lake evaporation were obtained from data for a stream-aquifer model of the alluvial Arkansas River valley from Pueblo to the Colorado-Kansas State line (Taylor and Luckey, 1972 and 1974). The monthly crop potential-evapotranspiration rates subsequently were adjusted downward, based on data for crop-consumptive use for the different administrative water districts (Don Miles, Colorado State University, written commun., 1968), for observed agricultural-consumptive use (Wheeler and Assoc., 1985), and for phreatophyte-consumptive use estimates (Bittinger and Stringham, 1963). All these sources used an annual value of about 2.5 feet. Monthly irrigation-diversion demand rates were parameters necessary to simulate the direct diversion of water during periods when the monthly crop potential-evapotranspiration rates were zero. These values were calculated from the diversion-record statistics. Monthly average diversions for all canals that had winter direct diversions were calculated on an acre-foot-diverted per acre-irrigated basis. Monthly average values for all those canals were calculated to produce a seasonal distribution. This seasonal distribution was set equal to the potential-evapotranspiration rates for the months during the growing season. The municipal- and industrial-demand factor was determined solely from calibration with the observed diversion data for Pueblo Water Works. The calibrated value of 0.13 provided the appropriate linear combination with the monthly irrigation-diversion demand rates to best fit the seasonal distribution of the average Pueblo Water Works diversions.

Another set of general basin information necessary for simulation is a set of factors: (1) Latitude and longitude to mile conversion factors; (2) sinuosity factors for computation of river miles; (3) a prestress factor to adjust initial return-flow values; (4) a canal seepage factor for simulating leakage from canals; and (5) an effective-precipitation factor. These factors generally are assigned or calibrated values that seem to fit the model best. The latitude and longitude to mile conversion factors are readily available mapping parameters; one value each is assumed acceptable for the entire basin. The sinuosity factors are used to calculate river miles between nodes that are identified by latitude-longitude locations. By using the latitude and longitude to mile conversion factors, a straight-line distance is computed; then these sinuosity factors are used to account for a sinuous stream. These values were adjusted so that calculated river miles along the river reasonably matched planimetered values obtained from maps. The prestress factor is part of a procedure to produce return flow from water-use activities that occurred before the model simulation. The model begins with all return flows set at zero, and if prestress were not included in the model, most of the early time return flows would remain zero until the newly simulated stresses resulted in return flow. So the system may begin in a quasi-equilibrium condition, 10 years of average conditions are simulated simply to build up a reasonable set of return flows. The canal-leakage factor was estimated to be 1 cubic foot per second per mile, based on general knowledge of the basin and selected seepage measurements and estimates (Wheeler and Assoc., 1985; Colorado Water Conservation Board, 1971; P.O. Abbott, U.S.

Geological Survey, written commun., 1984). The effective-precipitation factor is a threshold value; monthly precipitation in excess of this value is assumed not to contribute to beneficial crop-consumptive use.

Other required data include reservoir data such as: location; storage capacity and maximum surface area; and initial contents and dissolved-solids concentration. The maximum capacity and corresponding surface-area values were obtained from the U.S. Bureau of Reclamation (1969) and the U.S. Soil Conservation Service (1977). Because the surface area is used only for the calculation of evaporation, it was adjusted for certain reservoirs to facilitate evaporation rates other than the basinwide average.

Finally, data are required for the initial volume of ground water in storage and its dissolved-solids concentration for each reach and side along the river. The estimates for ground-water storage were obtained from the stream-aquifer model of the lower basin (Taylor and Luckey, 1972 and 1974); the estimates of dissolved-solids concentration were obtained from Cain (1987). The additional basin-description file for calibration is provided as Attachment D in the "Supplemental Information" section at the back of this report.

The information entered to the model to simulate the water-supply operations requires: (1) A code to indicate type of water user; (2) the number of units served by the user--irrigated acres for agricultural users, people served for municipal users, units produced for industrial users, and storage capacity of a reservoir for reservoir operators; (3) the demand factor and code; (4) a return-flow code; (5) a return-flow factor; and (6) the number of sources of supply. In addition, for each source of supply, the following data are required: (1) Type of source; (2) capacity of source; (3) location of source; and (4) distance from stream, used for the stream-depletion factor (SDF) for ground-water pumpage sources, or reservoir-identification number for reservoir releases. Most of these values are documented numbers and need little adjustment during the calibration process. The irrigated acreage for diversion canals was provided by Abbott (1986). The people served and units produced for the municipal and industrial users were adjusted to best match the observed diversion data. The demand factor and code were the primary parameters that were adjusted during calibration by matching simulated diversions to observed diversions. The code was used to determine whether the water demand for a particular water user followed the crop potential-evapotranspiration distribution (diverted only during the irrigation season) or the irrigation-diversion demand distribution (diverted during the winter). This value was determined during calibration based on the best statistical fit of the observed diversions. The demand factor was multiplied by the product of the consumptive rate of the particular distribution chosen and the number of units served by the user. The return-flow factor was initially set at 0.8 for all agricultural users, which means that 80 percent of their applied water, greater than that needed for crop consumptive use, would enter the ground-water system, and 20 percent would return to the river the following month as tailwater. This value was modified during calibration for each user to adjust the timing of return flow to the stream and to adjust ground-water storage. The return-flow code allows for other definitions of the return-flow factor. A few agricultural users (1431, HIGHLINE and 1716, FT LYON) irrigate some areas outside the alluvial aquifer, and excess irrigation applications in those areas cannot contribute return flow to the simulated system. For these

users, the return-flow factor represents the percent of the total return flow that remains in the simulated system. The return-flow factor can be coded to represent the percent of total diversion that returns to the system for municipal and industrial users. Data for sources of water were obtained from the list of water rights in the prior-appropriation system, enumerated by Abbott (1986). The ground-water pumpage capacity and weighted distance from the stream were determined from information in the stream-aquifer model (Taylor and Luckey, 1972 and 1974). The only parameter that required adjustment during calibration was the quantity of reservoir release. Although this value ought to be limited only by the storage capacity of the reservoir, observed data indicated these values were much smaller. The parameter was adjusted primarily based on the best fit of simulated and observed reservoir contents. All the data used for the 74 users in the basin water-user file are provided as Attachment E in the "Supplemental Information" section at the back of this report.

Calibration for 1943-74

As was discussed previously, the parameter data that are input to the model to describe the physical system is assumed static in time; that is, operating rules, reservoir sizes, crop demands, and so forth, do not change with time. Because the physical system has been dynamic, two periods were selected for calibration: 1943-74 and 1975-85. The physical system, as it operated in 1965, was selected for the primary calibration to represent 1943-74. The observed (or estimated, if records were missing) rainfall, snowpack, tributary inflow, and air temperature for 1943-74 were selected as the time series of independent variables to enter in the model. The period was selected to simulate conditions after John Martin Reservoir was constructed and before Pueblo Reservoir was operational. The statistical summaries of the simulated streamflow for the 1943-74 calibration is indicated by the MR, SDR, and R^2 listed in table 6. The coefficients of determination ranged from good (0.86 and 0.87) at several nodes, to poor (0.02 at node 1330, ARK LAMR).

The effects of water operations on streamflow are not large in the upper basin; so, for node locations upstream from Canon City, calibrated results with water use and ground water are similar to the results for the streamflow-only simulation. The adjustments that were made were the result of irrigation of hay meadows in the upper basin and the inclusion of the high-mountain reservoirs and corresponding reservoir releases. An example of the calibration fit for this reach is shown in figure 8, which presents simulated streamflow, differences between simulated and observed streamflow, and cumulative frequency curves for observed and simulated streamflow for node 915, ARK SLID.

In the river reach between node 960, ARK CANC, and node 1197, ARK CAT, water losses caused by irrigation diversions are offset somewhat by the inflow from several tributaries. The major difficulty in calibrating streamflow along this reach is in accounting for the large incremental inflows that occurred during a few peak months. Some months with peak streamflows correspond to months with substantial precipitation but, during some months, peak streamflow would occur when records indicated below normal precipitation or, during some months, no peak streamflow would occur when records indicated above normal precipitation. Thus, all the peaks could not be explained or properly simulated. An example of the calibration fit for this reach is shown in figure 9, which presents simulated streamflow, differences between simulated and observed streamflow, and cumulative frequency curves for observed and simulated streamflow for node 1170, ARK NPST.

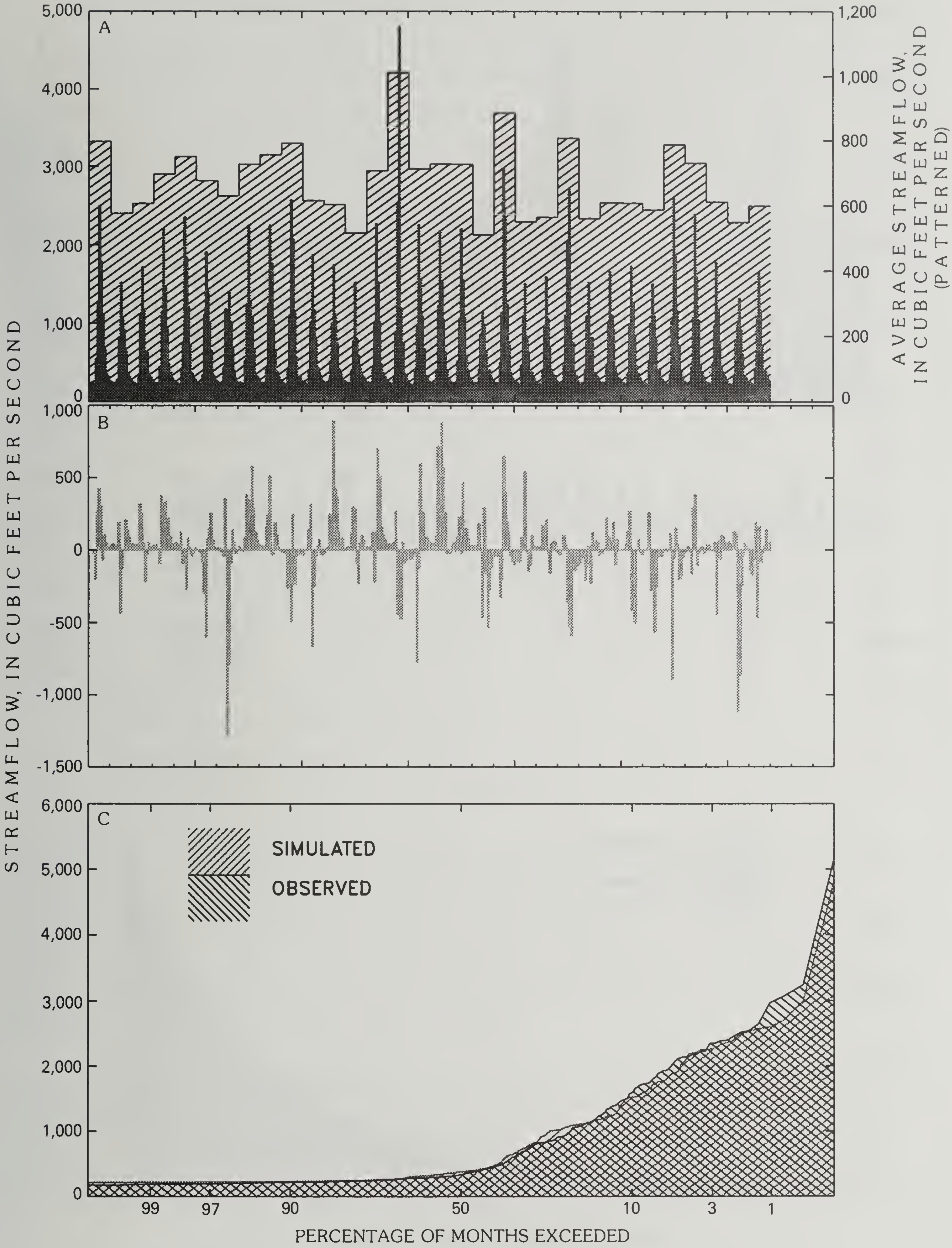

Figure 8.--Streamflow for node 915, ARK SLID, 1943-74: *A*, simulated streamflow; *B*, difference between observed and simulated streamflow; and *C*, cumulative frequency curves for the observed and simulated streamflow.

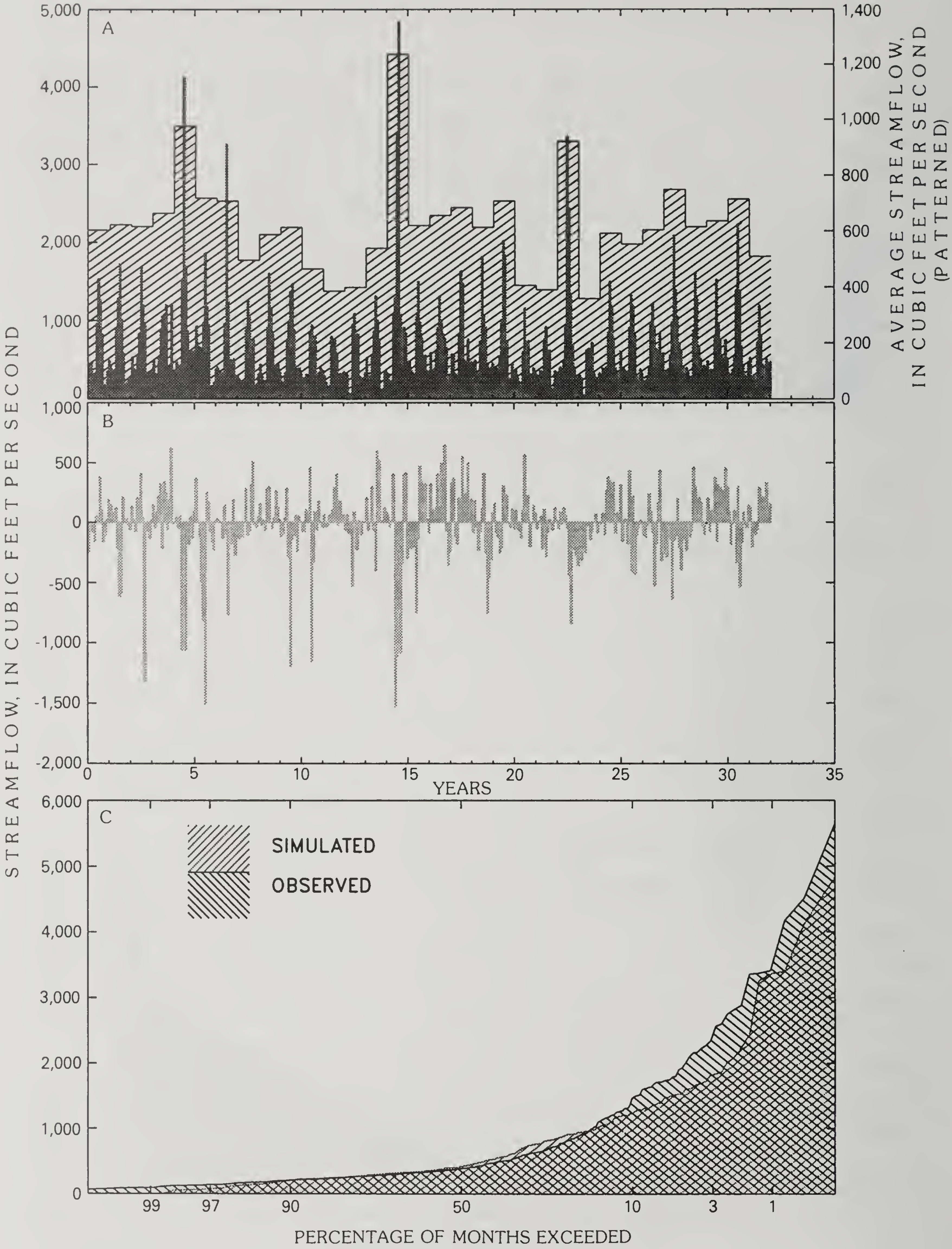

Figure 9.--Streamflow for node 1170, ARK NPST, 1943-74: *A*, simulated streamflow; *B*, difference between observed and simulated streamflow; and *C*, cumulative frequency curves for the observed and simulated streamflow.

Table 6.--*Statistics for node locations used in the 1943-74 model calibration*

[All flow values are in cubic feet per second]

Node ID[1]	Node name	Observed		Simulated		
		Mean	Standard deviation	Mean of the residuals (MR)	Standard deviation of the residuals (SDR)	Coefficient of determination (R^2)
860	ARK GRNT	399	428	8.5	156	0.87
915	ARK SLID	662	642	8.3	227	.87
945	ARK PARK	777	675	2.2	255	.86
960	ARK CANC	715	708	5.9	255	.87
994	ARK PUBL	642	698	4.0	288	.83
1095	ARK AVON	860	715	-4.5	277	.85
1170	ARK NPST	645	679	5.2	301	.80
1197	ARK CAT	603	548	4.7	234	.82
1230	ARK LAJU	194	385	7.9	230	.64
1240	ARK ANMS	166	345	3.2	213	.62
1305	ARK JM R	264	341	-4.5	300	.23
1330	ARK LAMR	115	217	-9.5	216	.02
1375	ARK COOL	225	513	3.6	189	.86

[1]See table 1 and figure 2 for node descriptions and locations.

Streamflow for the rest of the river reach downstream as far as John Martin Reservoir generally is quite small and is dominated by diversions and return flow. Thus, simulated streamflow in this reach is most affected by the ability of the model to simulate the water-supply operations. The problems with unaccountable incremental peak streamflow also are seen along this reach. An example of the calibration fit for this reach is shown in figure 10, which presents simulated streamflow, differences between observed and simulated streamflow, and cumulative frequency curves for simulated and observed streamflow for node 1240, ARK ANMS.

John Martin Dam was constructed to provide flood control and storage for irrigation in Colorado and Kansas. The ability of the model to simulate the water-supply operations of John Martin Reservoir is best demonstrated by comparing the observed and simulated streamflow for the node locations just downstream from the reservoir, 1305, ARK JM R (fig. 11). The reason for the poor statistical fit at this node (table 5) is that simplified operation rules fail to meet all of the actual release data.

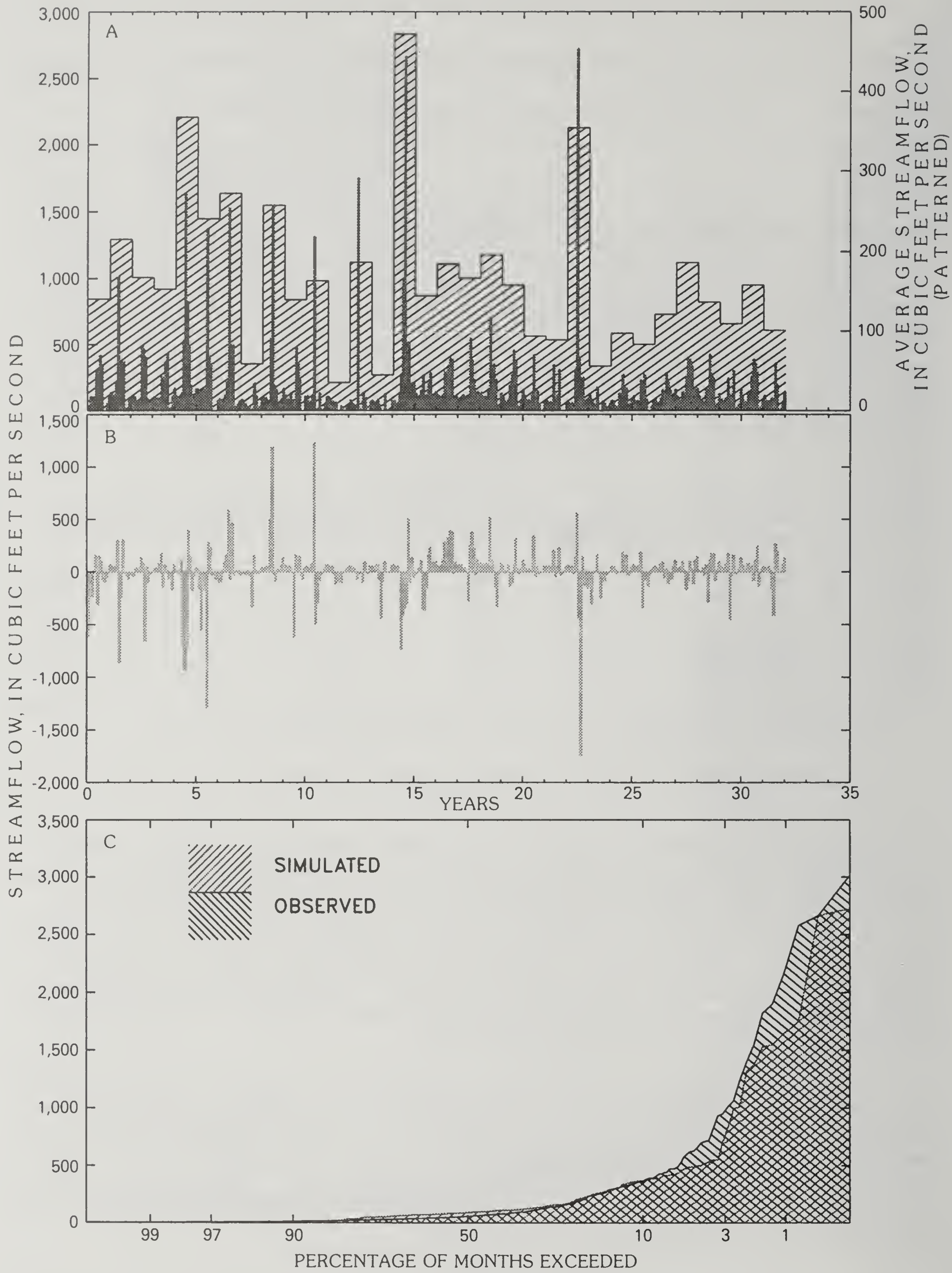

Figure 10.--Streamflow for node 1240, ARK ANMS, 1943-74: *A*, simulated streamflow; *B*, difference between observed and simulated streamflow; and *C*, cumulative frequency curves for the observed and simulated streamflow.

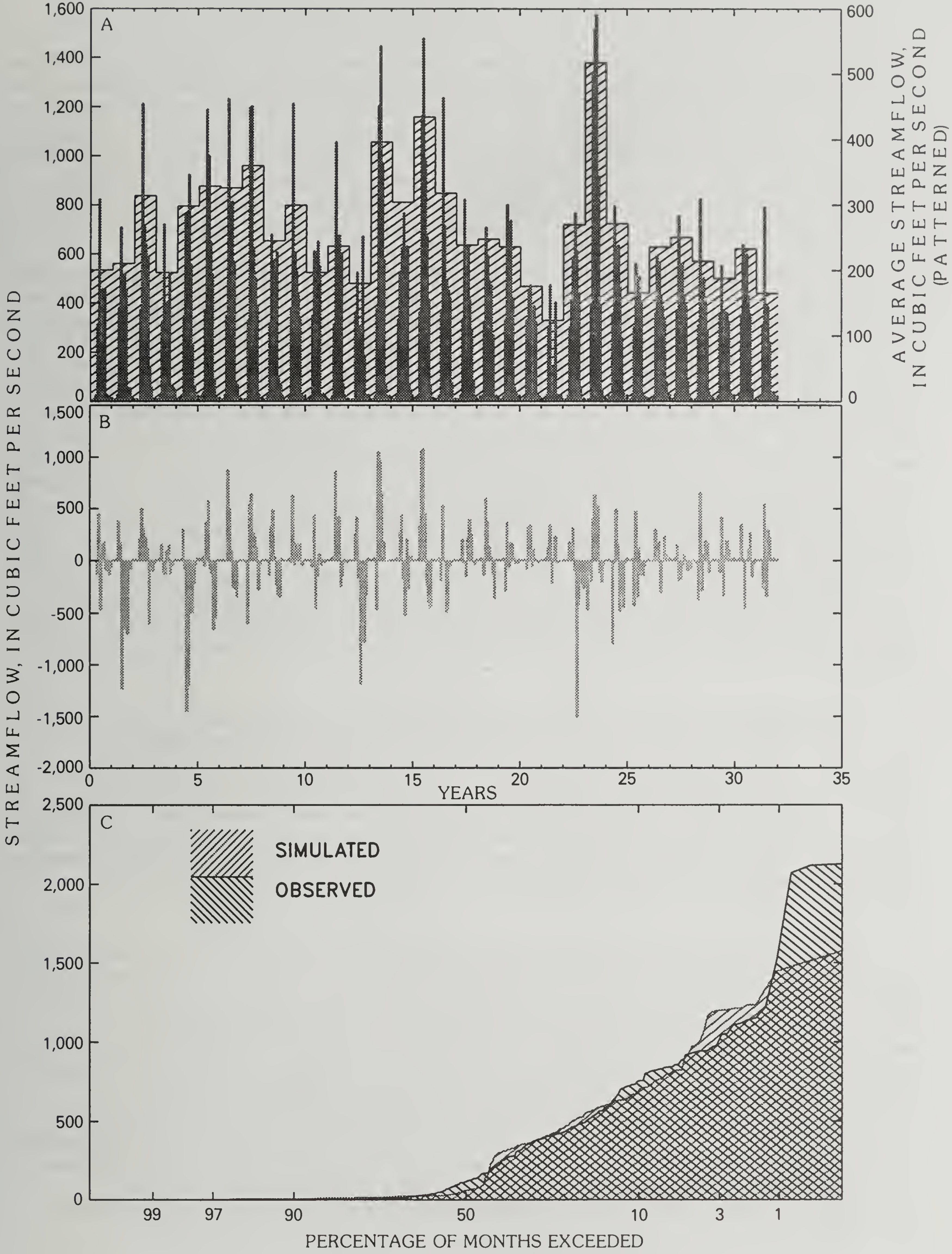

Figure 11.--Streamflow for node 1305, ARK JM R, 1943-74: *A*, simulated streamflow; *B*, difference between observed and simulated streamflow; and *C*, cumulative frequency curves for the observed and simulated streamflow.

The node location that is farthest downstream is 1375, ARK COOL. The flow at this node consists largely of return flow from irrigation and releases from John Martin Reservoir, except for the flood of 1965. In June 1965, local precipitation (18 inches) exceeded the average annual precipitation (15 inches), which caused the largest monthly flow during the period of record. An example of the calibration fit for this reach is shown in figure 12, which presents simulated streamflow, differences between observed and simulated streamflow, and cumulative frequency curves for observed and simulated streamflow.

The simulated water-supply operations included 74 water users: 57 irrigation canals, 11 reservoir operators, and 6 industrial or municipal suppliers. The model simulates direct and storage diversions, reservoir releases, ground-water pumpage, and transmountain imports based on demand curves and factors. The sum of all the simulated direct diversions for each month and the sum of all the simulated ground-water pumpage are shown in figure 13. The average annual sum of all simulated direct diversions was 1,039,000 acre-feet. The average annual sum of all simulated ground-water pumpage was 126,000 acre-feet. The statistical summaries of these simulated results are identified for selected users by the MR, SDR, and R^2 in table 7. The coefficients of determination that are calculated are not an exact mathematical computation because the standard deviations listed in table 7 indicate the entire period of available data. This error is not considered to introduce any bias into the calculation. The coefficients of determination range from good (0.87 for user 1143, RVRSD-AL) to negative. Selected plots of simulated diversions for various users show that, even though statistically the model may not fit an observed diversion record well, the model still is simulating reasonable conditions.

An example of a good fit of direct diversions was for user 1164, BILL-HAM. Observed diversions, simulated diversions, and the cumulative frequency curves for the observed and simulated diversions are shown in figure 14. An example of a statistically negative fit was for user 6707, AMITY. Although it is evident that differences occur between the observed diversions (fig. 15*A*) and the simulated diversions (fig. 15*B*), the cumulative frequency curves of observed and simulated diversions (fig. 15*C*) match reasonably well and indicate that the model is simulating the purport of the operating rules.

The poor statistical fit for users downstream from John Martin Reservoir primarily is caused by a lack of appropriate observed data. Those users have direct diversions and reservoir releases as possible sources of supply and, in fact, to best fit the reservoir contents of John Martin Reservoir, the model simulates the first source of supply as reservoir releases before using direct diversions. Unfortunately, the observed records do not distinguish between direct diversions and reservoir releases; apparently they are recorded together. An example of this shortcoming in the data is shown in figure 15. A flood in 1965 (year 23 on fig. 15) enabled John Martin Reservoir to fill; thus, the model simulated almost no direct diversions in 1966 (year 24 on fig. 15*B*) as users satisfied their water demands with reservoir releases. However, large observed diversions were recorded for that year (fig. 15*A*).

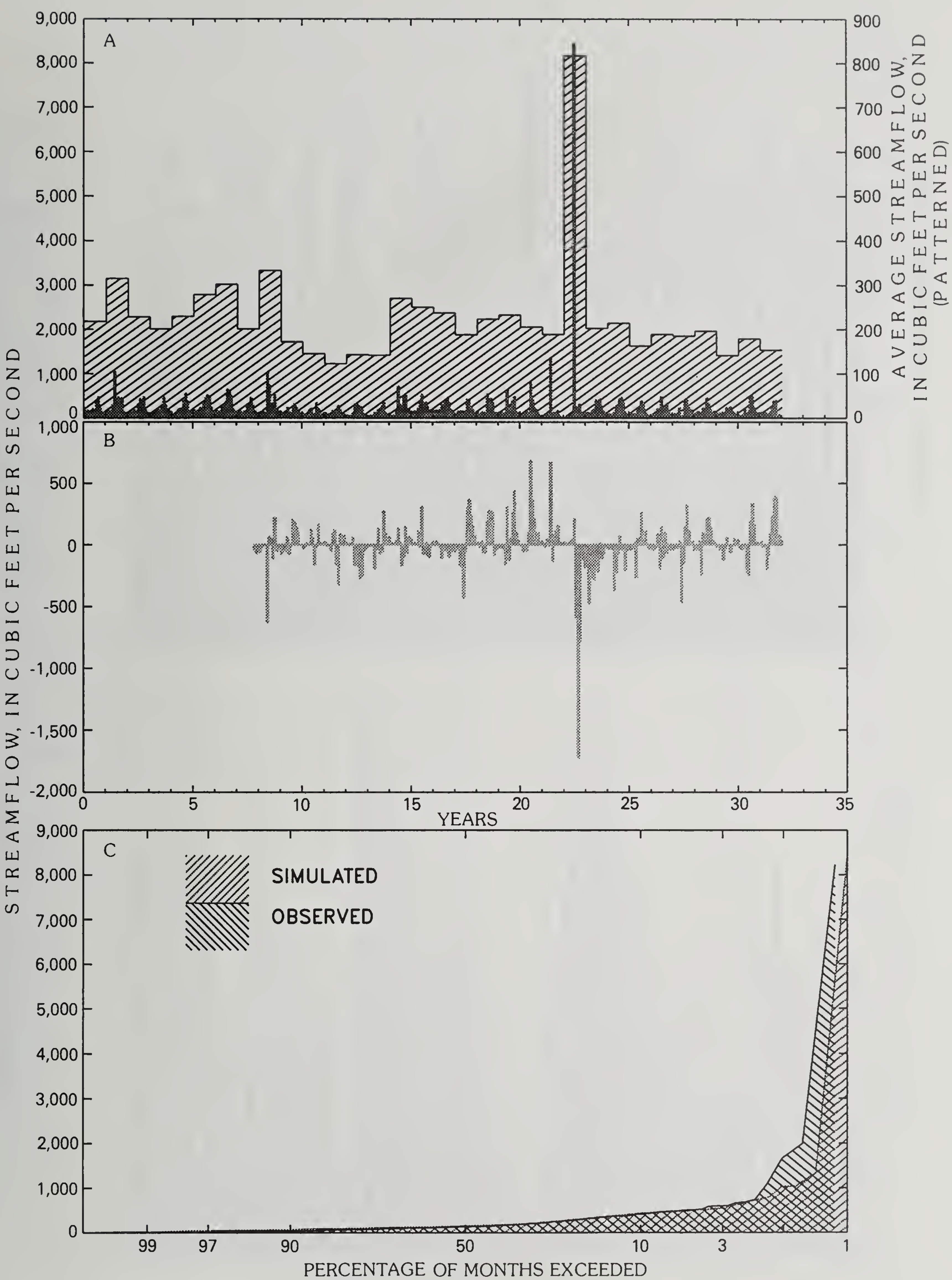

Figure 12.--Streamflow for node 1375, ARK COOL, 1943-74: *A*, simulated streamflow; *B*, difference between observed and simulated streamflow; and *C*, cumulative frequency curves for the observed and simulated streamflow.

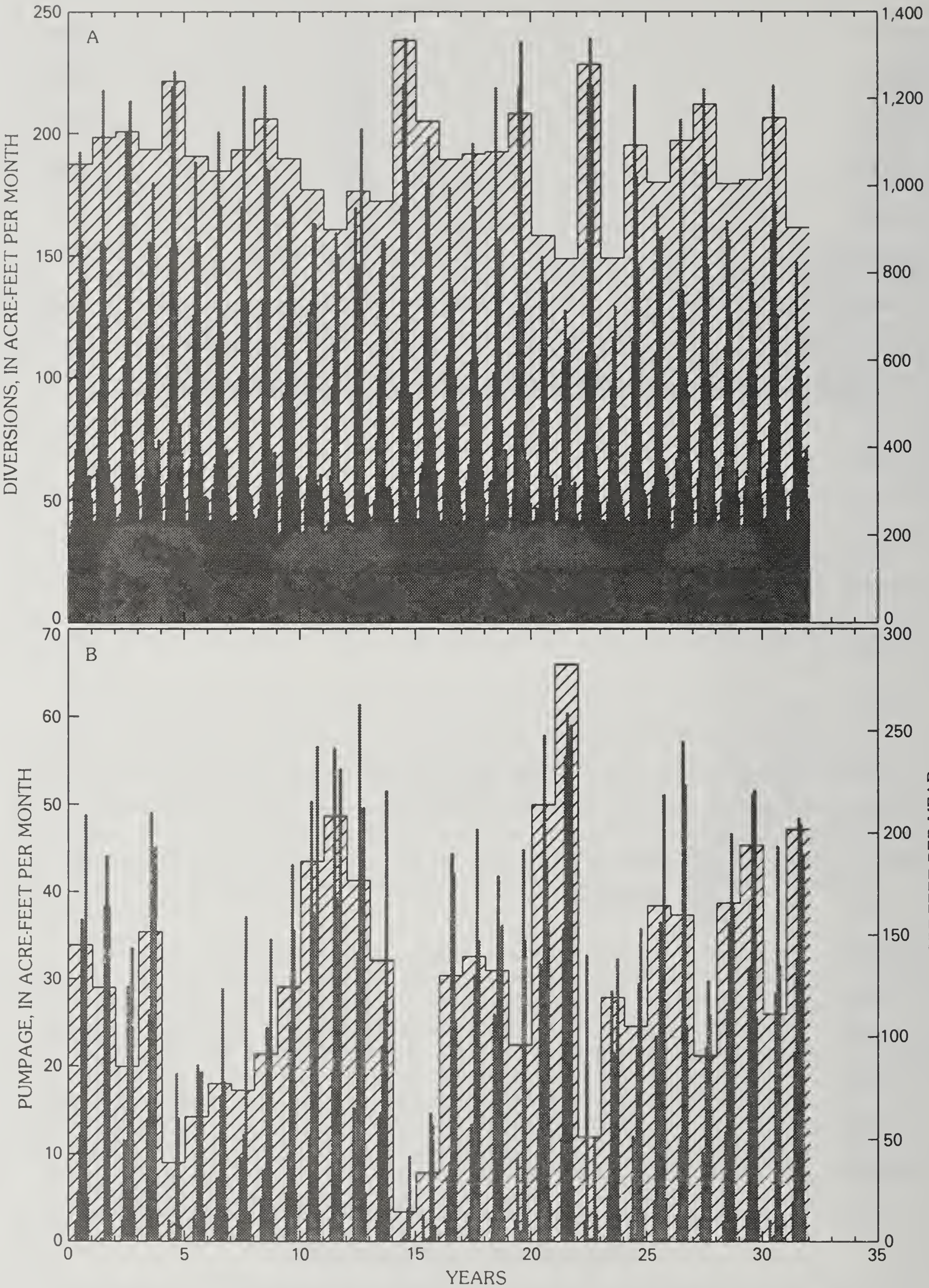

Figure 13.--Basinwide water use, 1943-74: *A*, simulated direct diversions; and *B*, simulated ground-water pumpage.

Table 7.--*Statistics of direct diversions for simulated water users, 1943-74*

[All diversion values are in acre-feet per month]

Water-user ID	Water-user name[1]	Observed Mean	Observed Standard deviation	Simulated Mean of the residuals (MR)	Simulated Standard deviation of the residuals (SDR)	Simulated Coefficient of determination (R^2)
1143	RVRSD-AL	298	384	9.2	137	0.87
1146	HELENA	366	520	-14.6	290	.69
1161	SUNNY PK	373	434	-29.2	242	.68
1164	BILL-HAM	382	438	-8.1	166	.86
1204	PLEASANT	206	239	-12.7	138	.66
1210	S CANON	1,270	993	-148	727	.44
1215	S C POWR	3,050	1,060	-281	860	.27
1216	HYD-FRUT	2,230	1,490	43.5	849	.67
1219	OIL CK	989	502	26.3	379	.43
1220	FREMONT	563	458	-46.0	285	.60
1222	CF&I	5,210	1,630	-73.4	1,520	.13
1228	HNNKRATT	56.5	86.6	-5.3	65.3	.43
1231	L ATTRBY	87.0	99.7	-5.9	65.9	.56
1234	IDEAL CM	147	115	-5.5	130	-.28
1401	BESSEMER	4,960	3,730	520	2,260	.61
1407	W PUEBLO	122	148	-15.4	85.4	.66
1410	PUEBL WW	2,040	811	13.8	334	.83
1419	BTH-ORCH	710	448	-218	340	.19
1422	EXCLSIOR	363	631	186	733	-.44
1425	COLLIER	72.3	200	18.2	157	.38
1428	COLORADO	4,510	7,920	-1,620	5,850	.41
1431	HIGHLINE	6,190	4,360	330	2,900	.55
1434	OXFD-FRM	1,940	1,780	-15.9	1,190	.55
1701	OTERO	629	1,070	-271	808	.37
1704	CATLIN	6,720	4,850	-380	3,180	.56
1707	HOLBROOK	3,110	3,840	202	3,510	.16
1710	RCKY FRD	3,920	1,880	-195	1,190	.59
1716	FT LYON	18,600	14,400	3,820	10,400	.41
1719	LAS ANMS	2,110	1,640	50.9	1,090	.56
6701	KEESEE	372	334	-81.5	287	.20
6704	FT BENT	1,300	1,300	-709	1,350	-.38
6707	AMITY	6,370	7,280	-1,270	7,530	-.10
6710	LAMAR	2,860	2,350	-99.4	2,440	-.08
6713	HYDE	149	159	-57.9	181	-.43
6716	MANVEL	184	337	-45.3	288	.25
6719	X-Y GRHM	493	637	333	687	-.44
6722	BUFFALO	1,410	1,190	-435	1,040	.10

[1]Water-user names and locations are identified in Abbott, 1985, table 4, and plates 2 and 3.

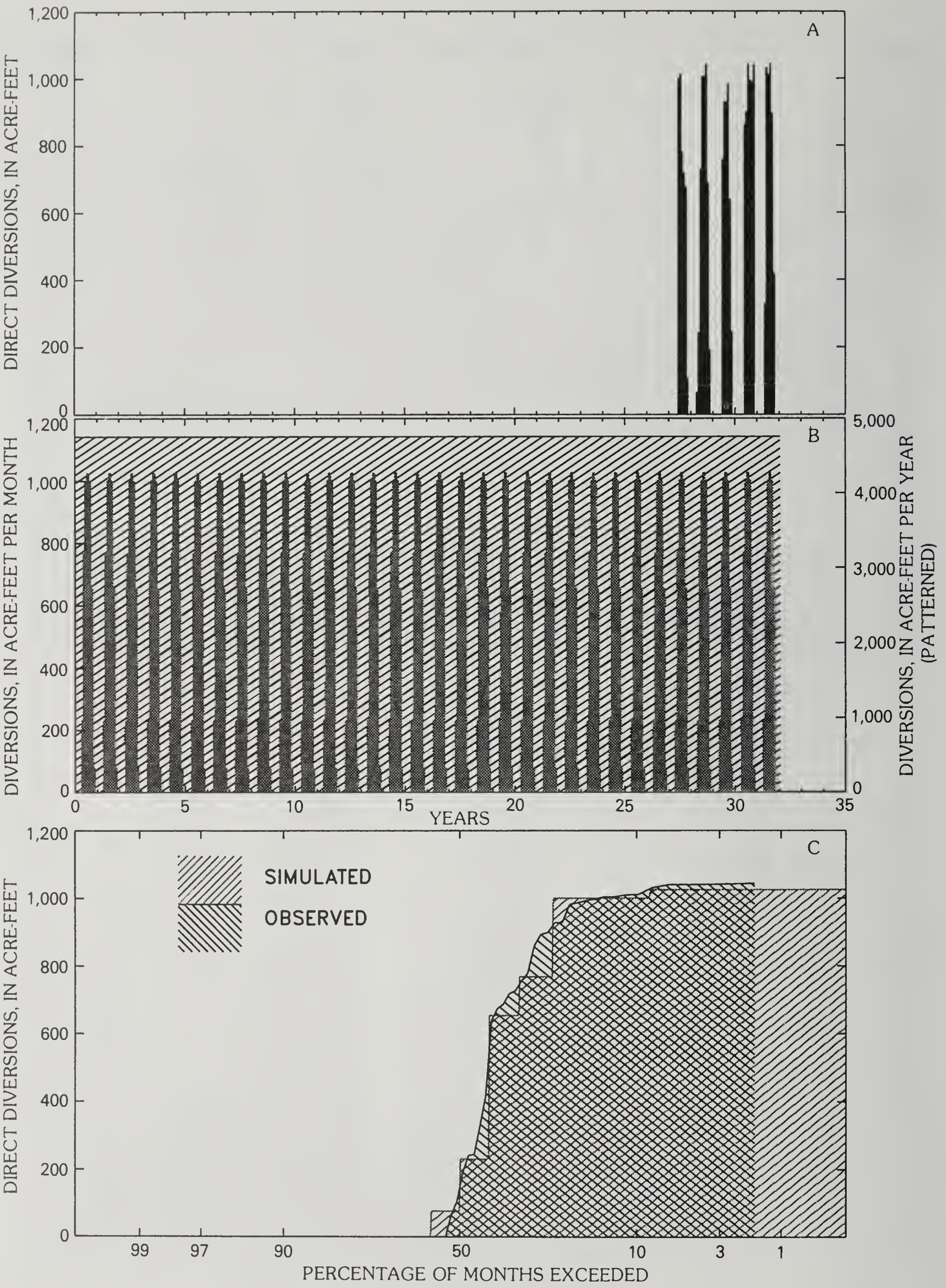

Figure 14.--Diversions for user 1164, BILL-HAM, 1943-74: *A*, observed diversions; *B*, simulated diversions; and *C*, cumulative frequency curves of observed and simulated diversions.

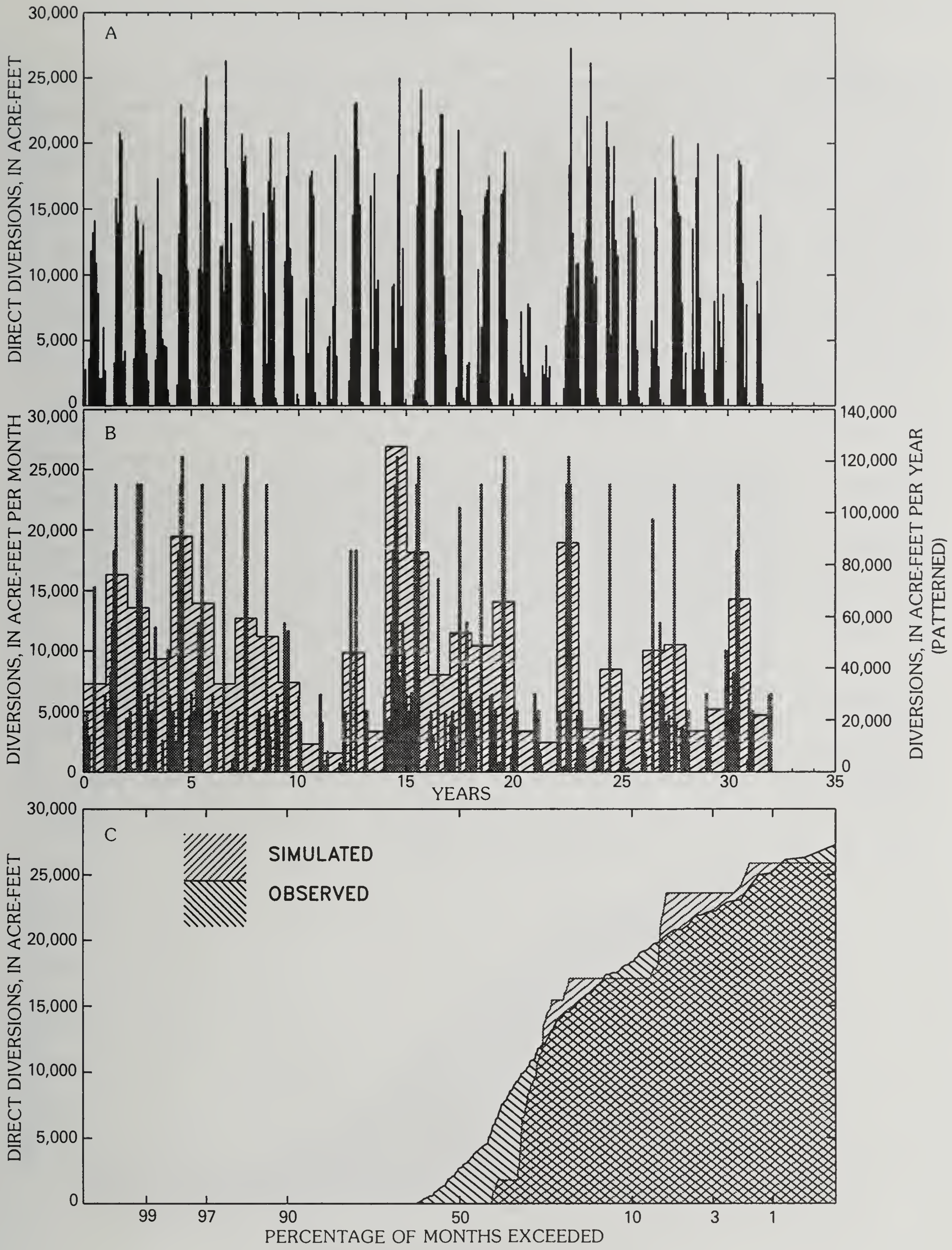

Figure 15.--Diversions for user 6707, AMITY, 1943-74: *A*, observed diversions; *B*, simulated diversions; and *C*, cumulative frequency curves of observed and simulated diversions.

A difficulty that occurred for several users is exemplified by user 1710, RCKY FRD (fig. 16). The demand factor could not be large enough to fit the peak diversions and small enough to fit the diversions during the remaining months. Another cause for a poor fit of observed data is that for some of the lower priority users, the model did not simulate diversions for a sufficient number of months--for example, user 1428, COLORADO (fig. 17). This lack of simulated diversions may be the result of the monthly time step that was not adequate to correctly simulate the shorter periods when the lower priority users would be making diversions. For some users, the observed data seemed very inconsistent. These inconsistencies ranged from gradual trends that probably represent true changes in the observed operation to instances where data seemed to be in error. For example, a plot of the difference between simulated and observed diversions in figure 18 for user 1216, HYD-FRUT, shows a period when the model always over-predicted, a period of relatively even over- and under-prediction, and after a period of missing observed record, a more recent period of general under-prediction. For this user, the observed data had a definite trend that the model could not simulate. A final item that could account for some of the lower statistical fits is that the seasonal average of the observed diversions for some users was between the all-winter diversion and the irrigation-season-only diversion options in the model. An example of this situation is shown by the frequency curves for user 1419, BTH-ORCH (fig. 19). The observed data have zero diversions for about 20 percent of the months, too often to be classified as all-winter diversion; but the irrigation-season-only simulated diversions show zero diversions about 40 percent of the time.

The rest of the physical system simulated by the model includes the ground-water system and the reservoirs. The simulated return flow from the aquifer to the river for its entire simulated length is shown in figure 20. Examples of the observed and simulated reservoir contents are shown for reservoir 854, TWIN LKS (fig. 21) in the upper basin, and reservoir 1107, MEREDITH (fig. 22) and reservoir 1300, JM RES (fig. 23) in the lower basin. Because recorded data generally are insufficient and because storage is a cumulative measure, statistics were not computed for the reservoirs. The plots show the general reasonableness of the simulated results.

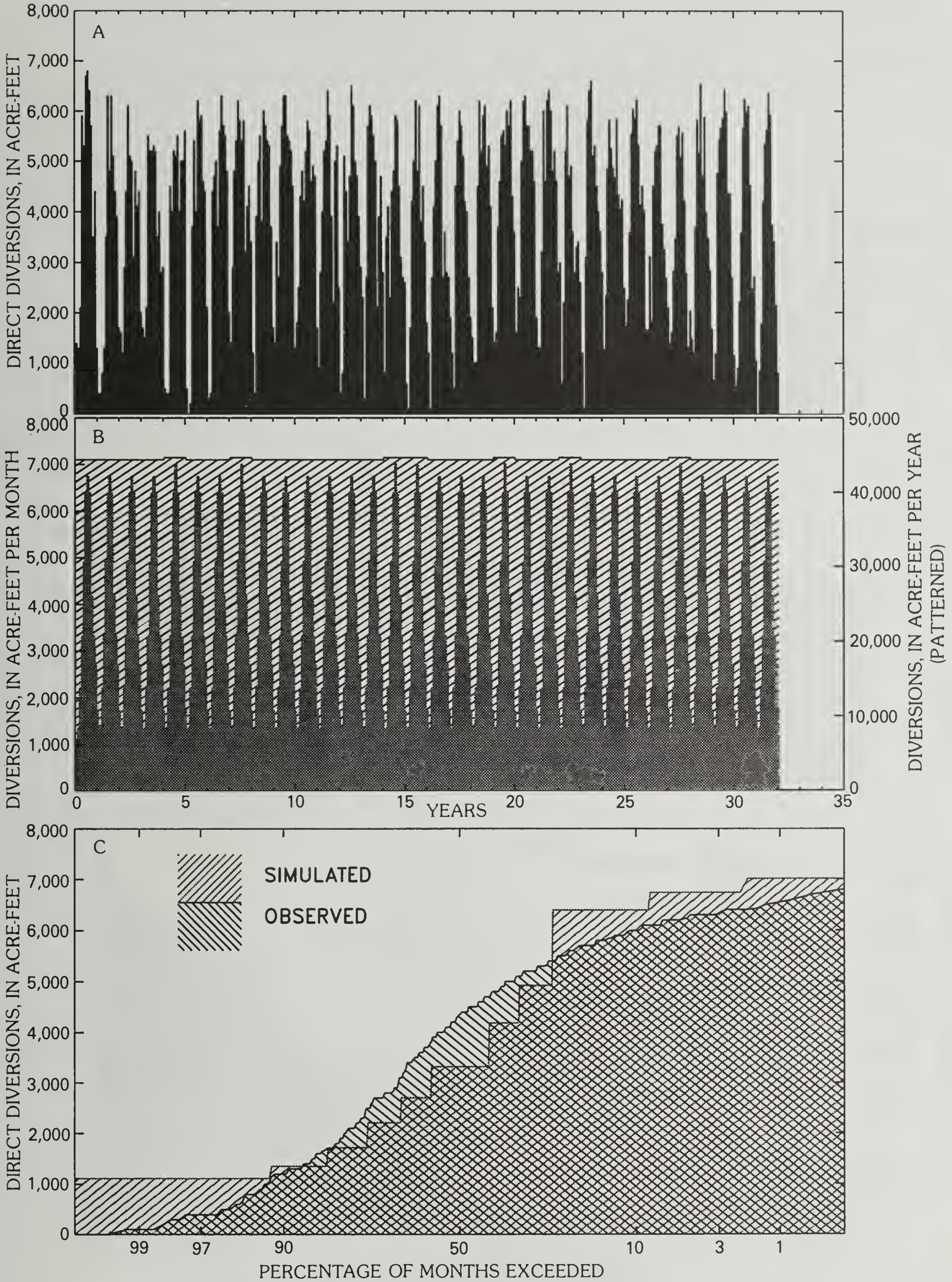

Figure 16.--Diversions for user 1710, RCKY FRD, 1943-74: *A*, observed diversions; *B*, simulated diversions; and *C*, cumulative frequency curves of observed and simulated diversions.

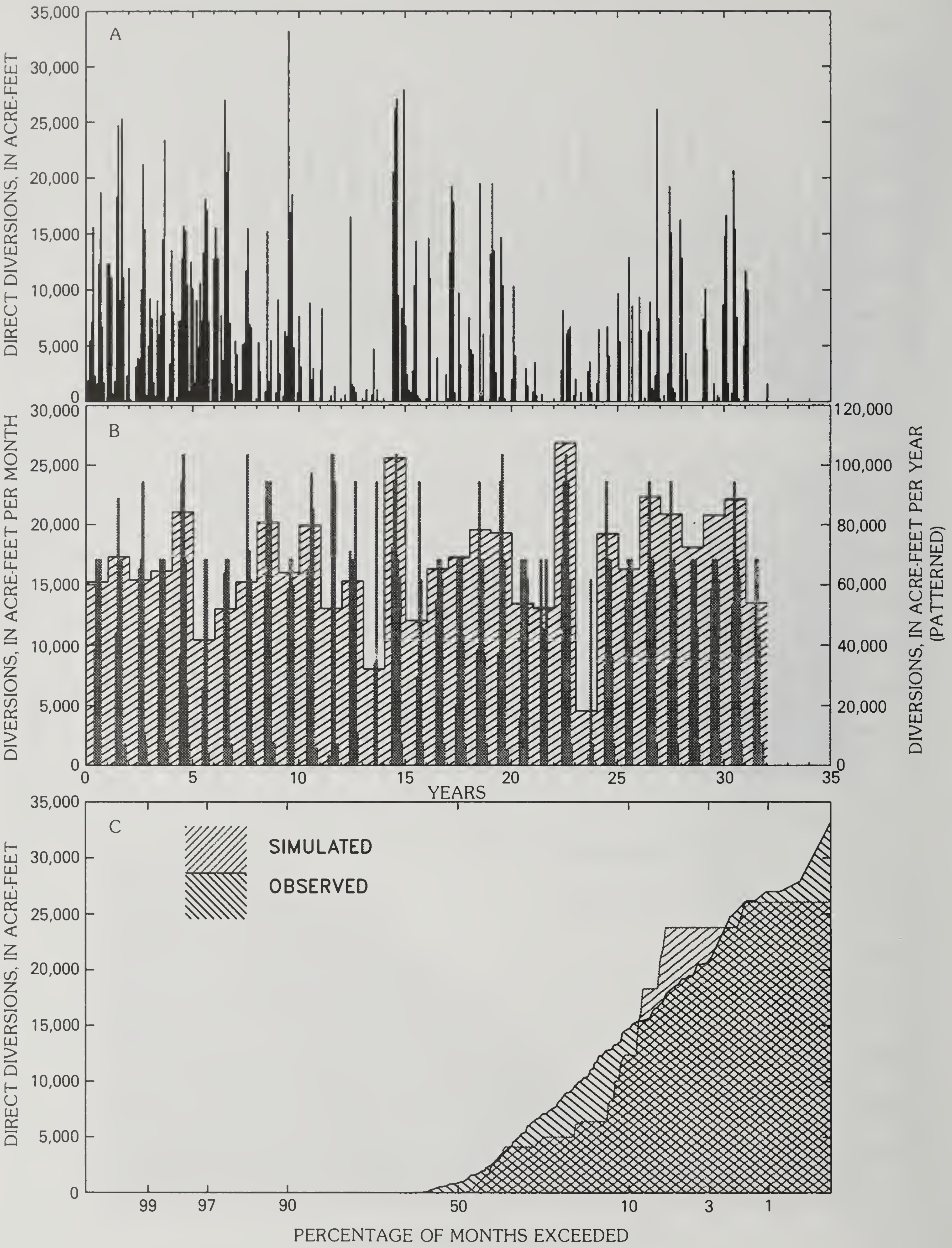

Figure 17.--Diversions for user 1428, COLORADO, 1943-74: *A*, observed diversions; *B*, simulated diversions; and *C*, cumulative frequency curves of observed and simulated diversions.

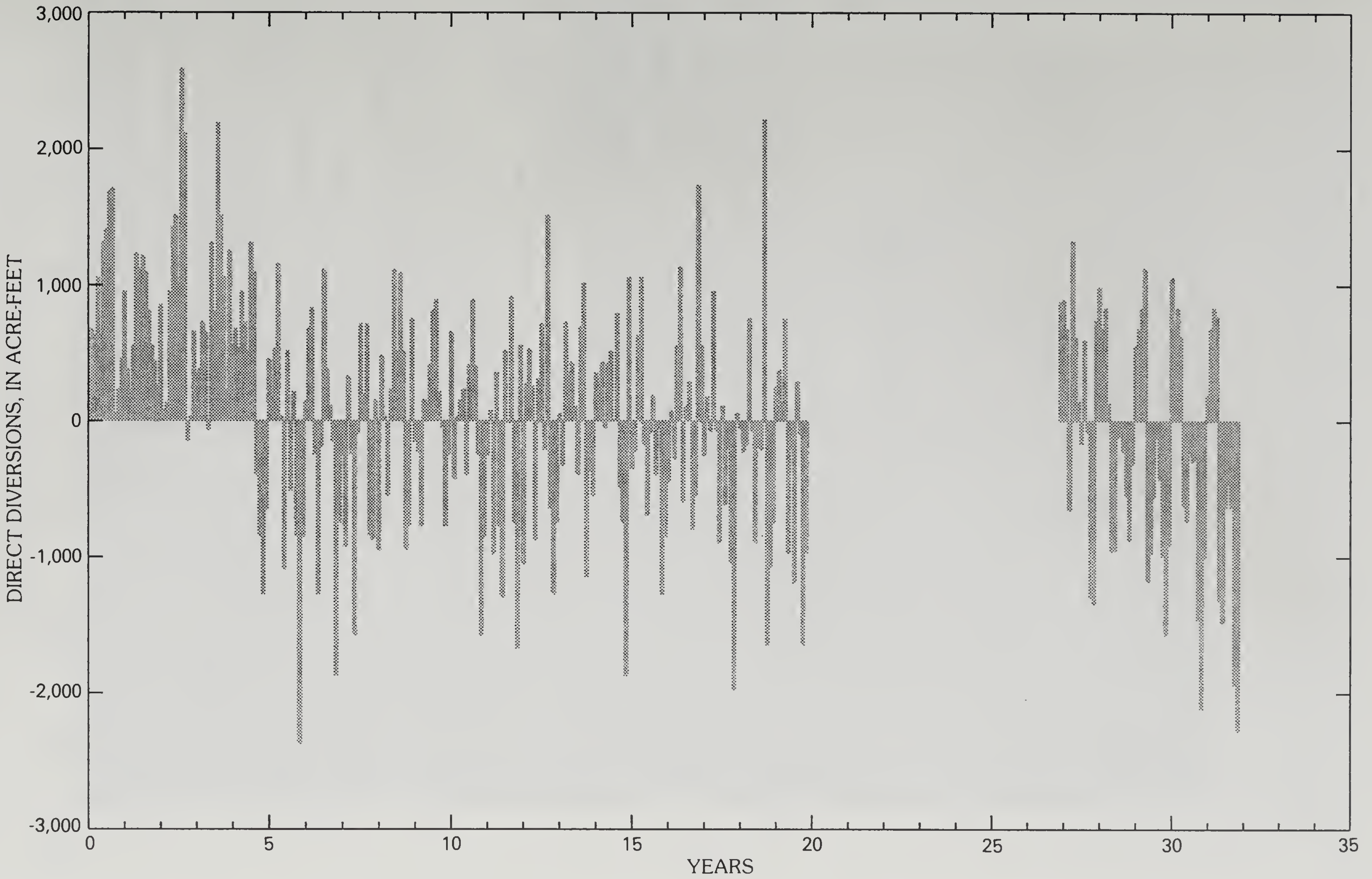

Figure 18.--Differences between simulated and observed diversions for user 1216, HYD-FRUT, 1943-74.

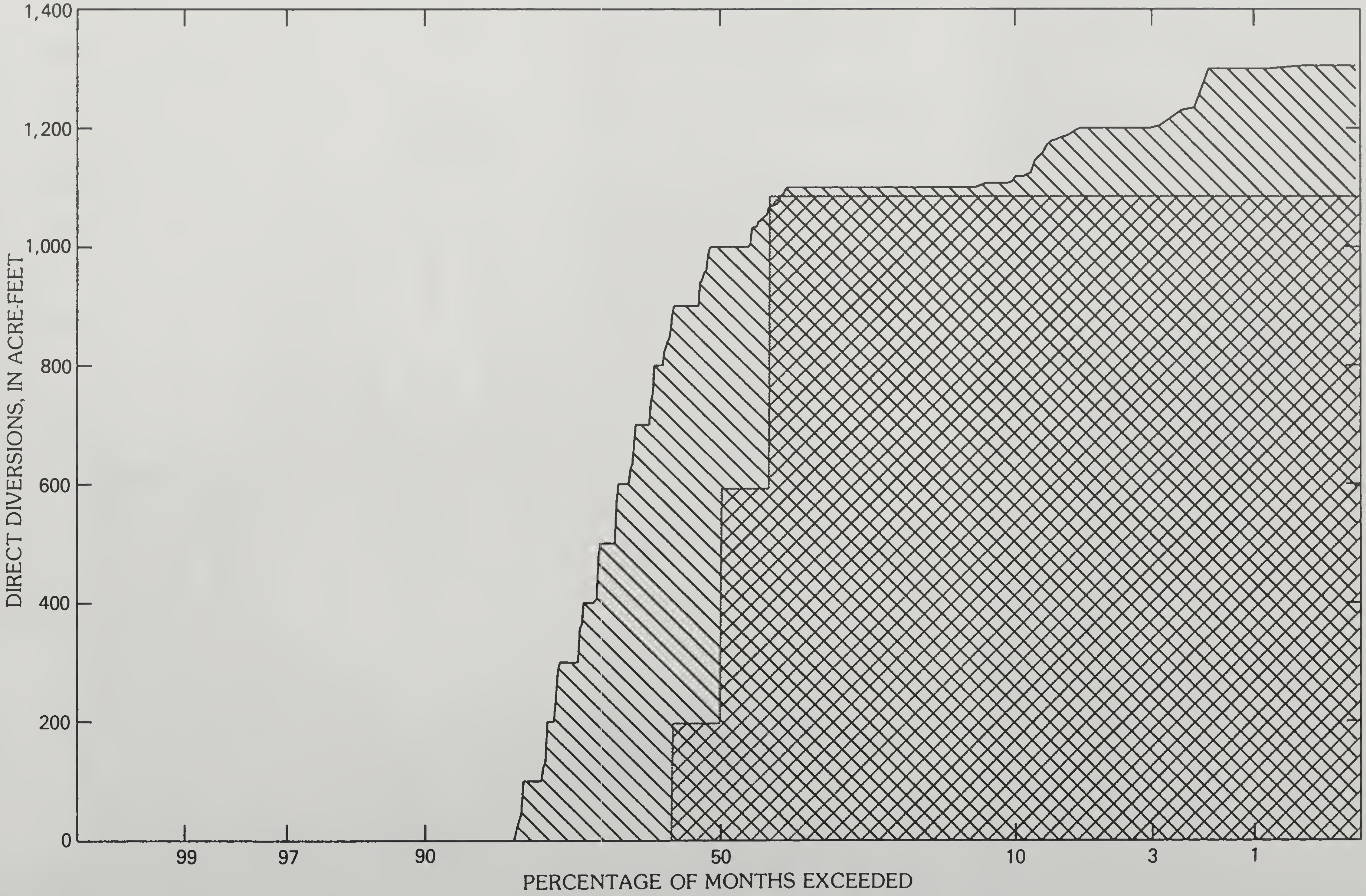

Figure 19.--Cumulative frequency curves of observed and simulated diversions for user 1419, BTH-ORCH, 1943-74.

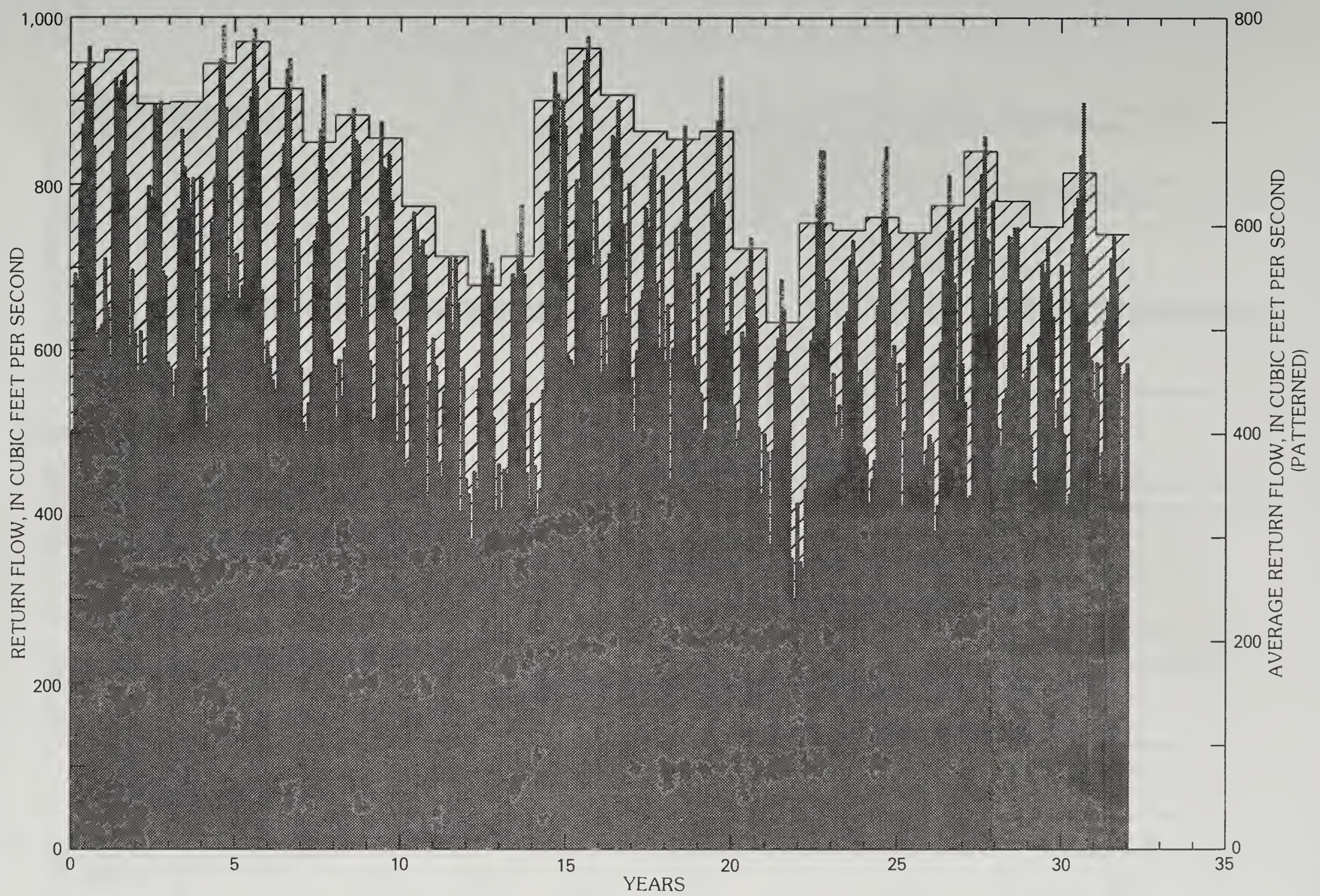

Figure 20.--Simulated ground-water return flows summed for all reaches in the basin, 1943-74.

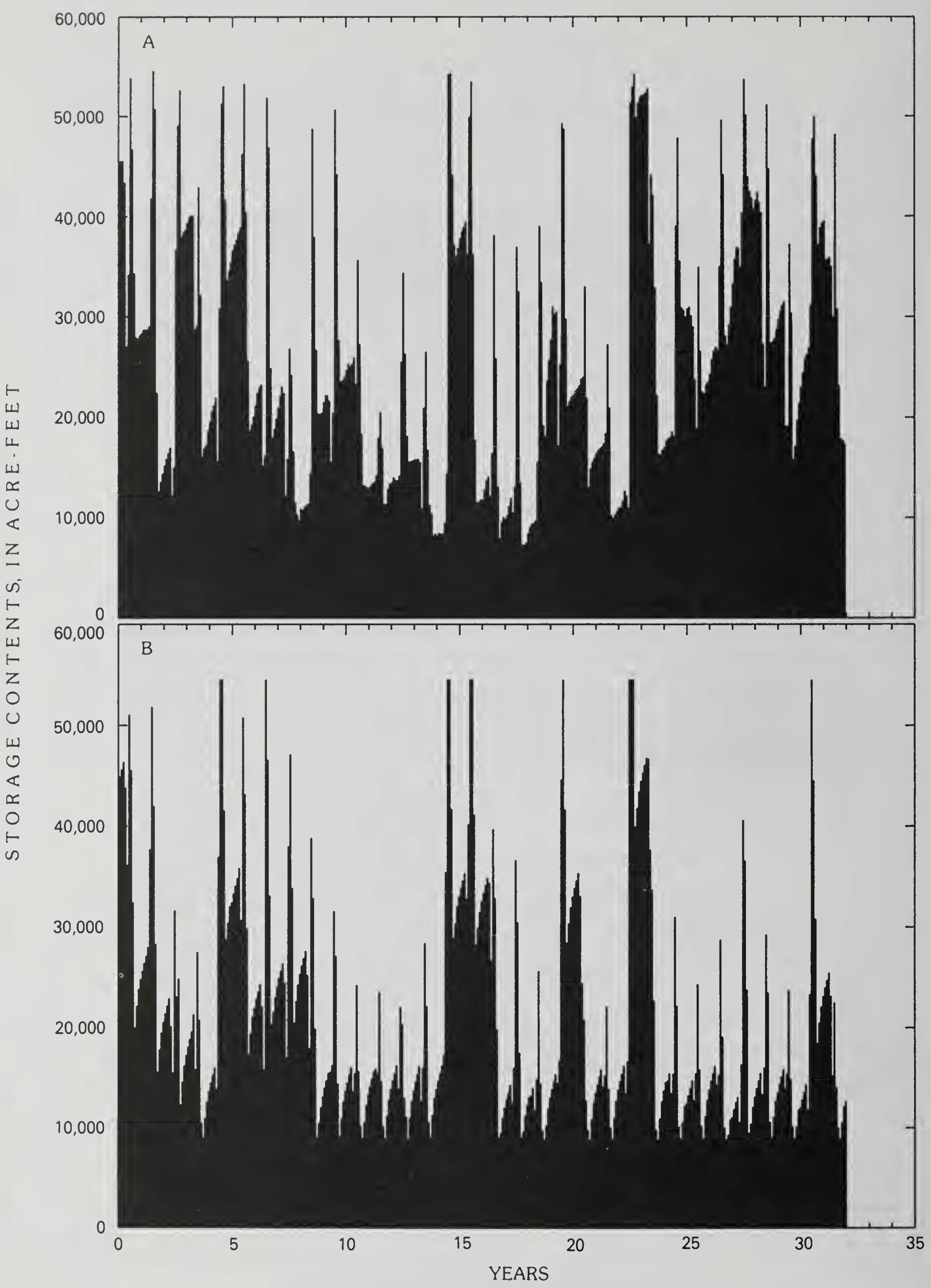

Figure 21.--Content for reservoir 854, TWIN LKS, 1943-74: *A*, observed reservoir content; and *B*, simulated reservoir content.

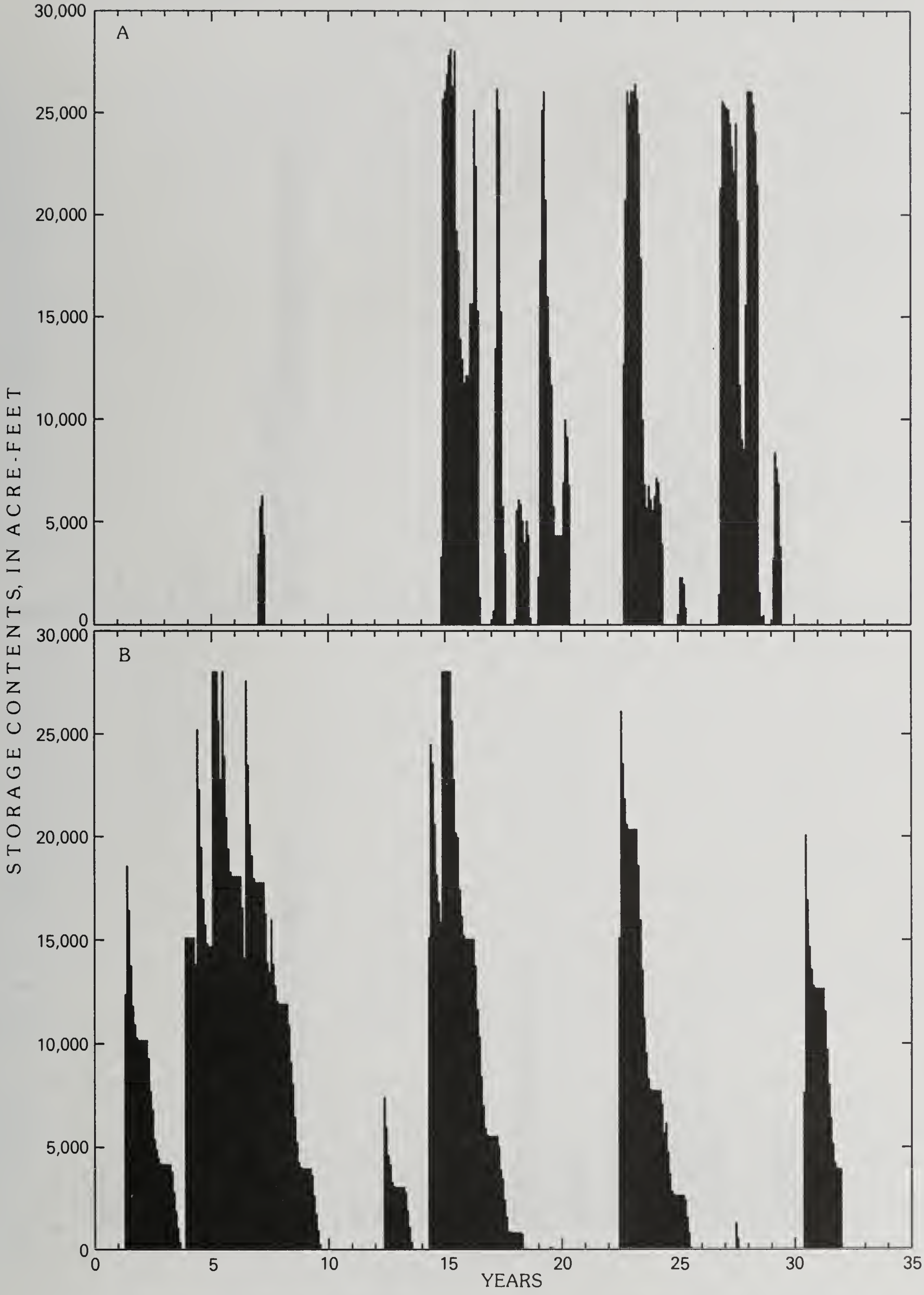

Figure 22.--Content for reservoir 1107, MEREDITH, 1943-74: *A*, observed reservoir content; and *B*, simulated reservoir content.

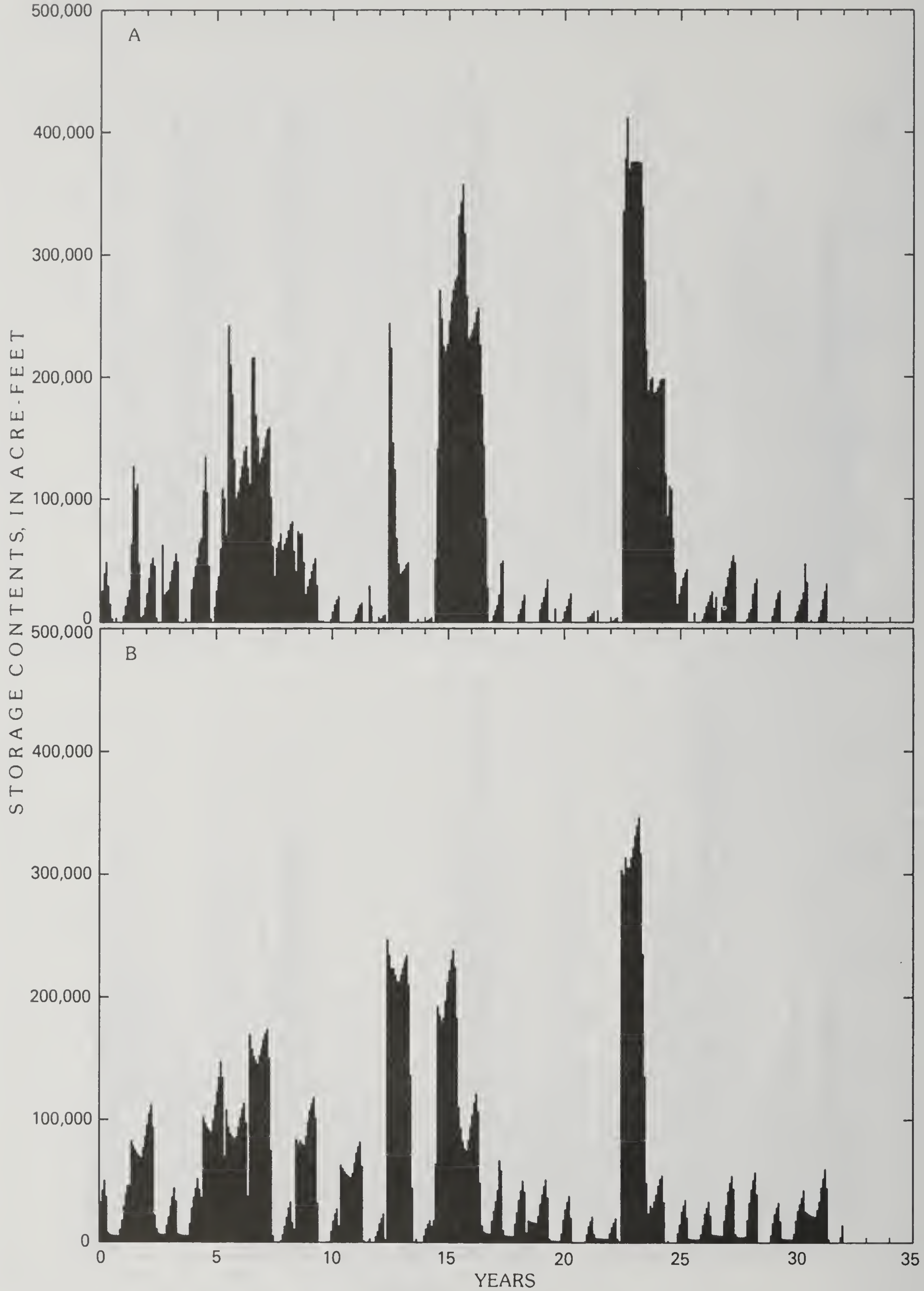

Figure 23.--Content for reservoir 1300, JM RES, 1943-74: *A*, observed reservoir content; and *B*, simulated reservoir content.

Calibration for 1975-85

Upon completion of the model calibration for the 1943-74 period, the model was used to simulate the 1975-85 period. Although this period is rather short to be used to obtain statistical measures for calibration, and even though many changes in water-supply operations were occurring throughout that decade, the model was used to simulate the Fryingpan-Arkansas project. The major changes needed in the model data to simulate this project were: (1) Inclusion of an import streamflow node to generate the transbasin streamflow of the Boustead Tunnel; (2) enlargement of reservoir 824, TURQUOIS and reservoir 854, TWIN LKS; (3) inclusion of reservoir 993, PUEBLO R; (4) addition of Pueblo Reservoir (Fryingpan-Arkansas project water) as a potential source to many of the water users, which permits each user a percentage of water in storage based on the historic allocation; and (5) development of a method for simulating the winter-water storage plan, in which those water users that historically had direct diversions during the winter could store those diversions in Pueblo Reservoir for later use during the irrigation season. The data used for the basin-description file for 1975-85 are provided as Attachment F in the "Supplemental Information" section at the back of this report; the additional basin-description file is included as Attachment G in the "Supplemental Information" section; and the water-user file is included as Attachment H in the "Supplemental Information" section.

To demonstrate the applicability of the model to the 1975-85 period and the changes introduced from the 1943-74 period, several components of the Fryingpan-Arkansas project were evaluated. The monthly average simulated transbasin imports through the Boustead Tunnel compare favorably to the observed monthly average diversions (table 8). Pueblo Reservoir is a multiple-use reservoir, but the model can account for separate activities within the reservoir. The average monthly simulated winter storage water entering reservoir 993, PUEBLO R during 1975-85 was 22,300 acre-feet in December; 18,000 acre-feet in January; 11,400 acre-feet in February; and 5,800 acre-feet in March. The model also simulated an average diversion of 5,500 acre-feet per year from the storage right for native water. The excellent correspondence between observed and simulated reservoir content for 824, TURQUOIS further accredits the simulation process of transmountain imports and releases of those imports. The observed and simulated results for 854, TWIN LKS also match very well until 1984, when either the reservoir was enlarged or the methods of reporting observed contents were changed. As a final demonstration of the simulation capability of the model, the simulated and observed contents of reservoirs 824, TURQUOIS (fig. 24); 854, TWIN LKS (fig. 25); and 993, PUEBLO R (fig. 26) for 1975-85 are shown.

Observed and simulated reservoir content for 993, PUEBLO R does not match as well as for the other two reservoirs. An unusually late snowfall in 1983 (year 8) caused higher streamflow than predicted by the model, which uses April 1 snowpack records. However, a more important factor that also causes the disparity is that municipalities allowed approximately 70,000 acre-feet to remain in storage while pipelines were under construction. This long-term storage of transmountain import water was not simulated as part of the 1975-85 reservoir conditions; thus, simulated reservoir content remained lower than observed content near the end of the simulated period.

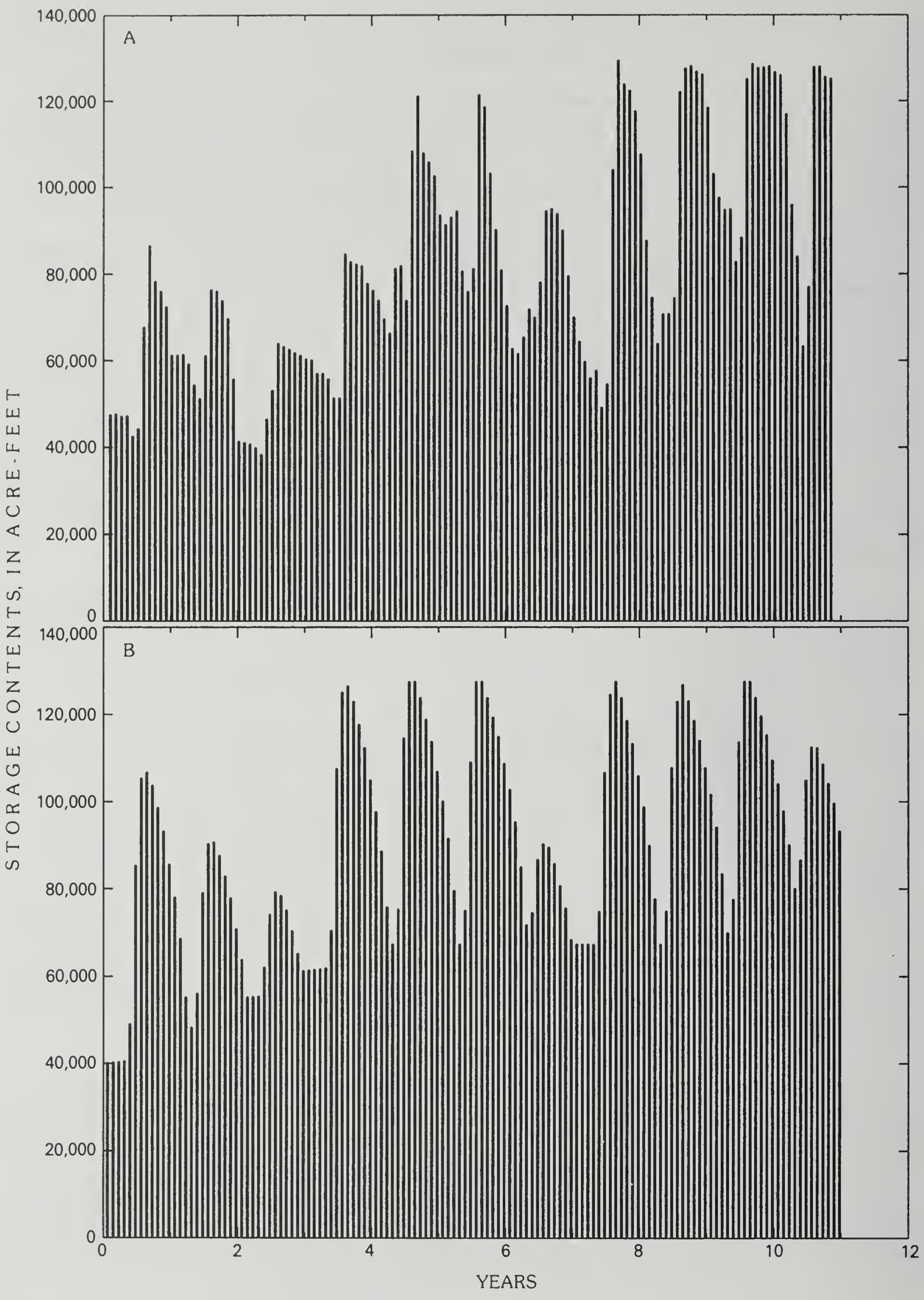

Figure 24.--Content for reservoir 824, TURQUOIS, 1975-85: *A*, observed reservoir content; and *B*, simulated reservoir content.

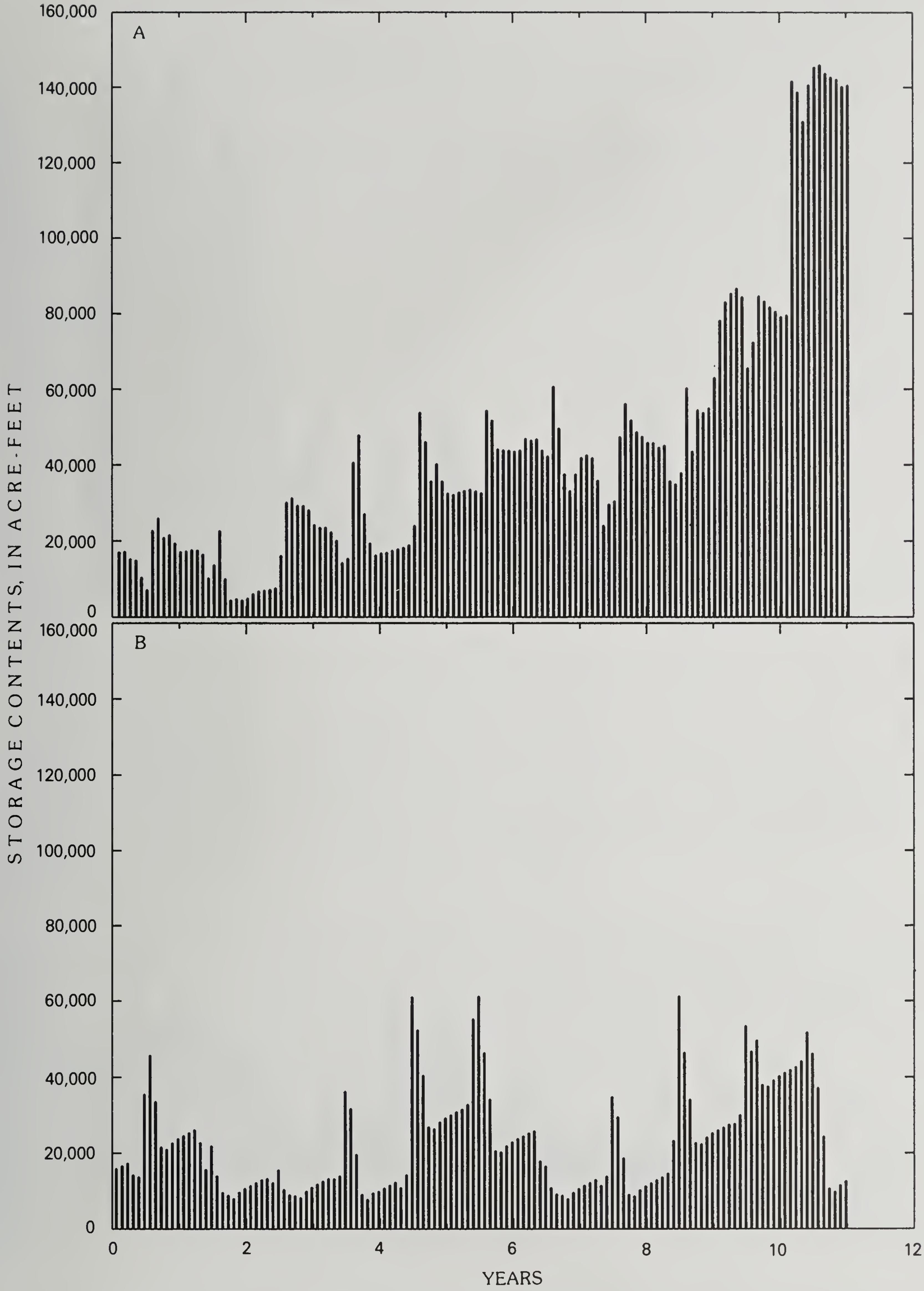

Figure 25.--Content for reservoir 854, TWIN LKS, 1975-85: *A*, observed reservoir content; and *B*, simulated reservoir content.

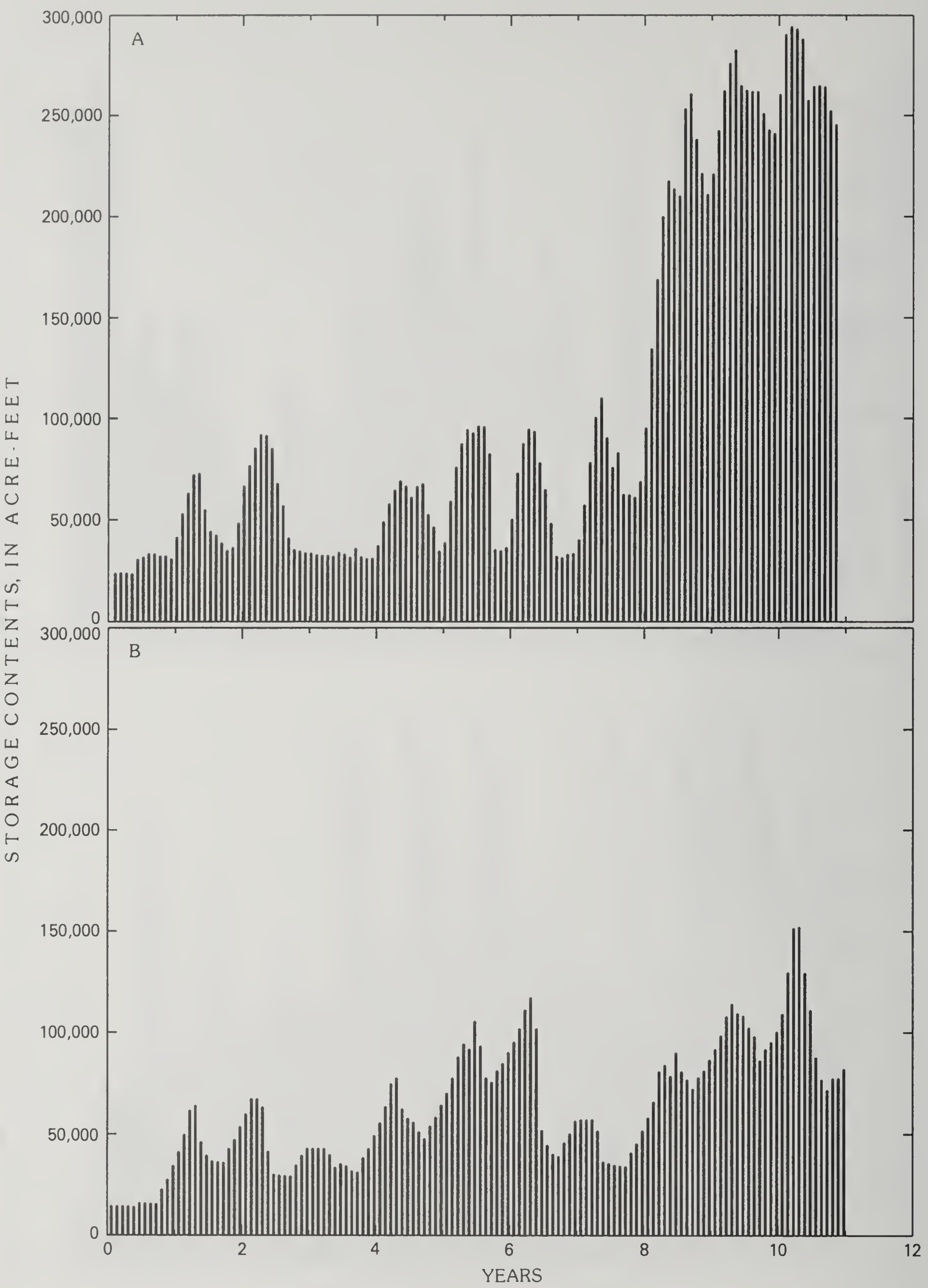

Figure 26.--Content for reservoir 993, PUEBLO R, 1975-85: *A*, observed reservoir content; and *B*, simulated reservoir content.

Table 8.--*Monthly average transmountain imports for observed and simulated diversions through the Boustead Tunnel*

[All diversion values are in acre-feet]

Month	Observed	Simulated
Jan.	0	0
Feb.	0	0
Mar.	0	0
Apr.	100	0
May	8,300	7,900
June	29,400	29,300
July	14,400	13,200
Aug.	3,000	4,000
Sept.	300	200
Oct.	200	100
Nov.	0	0
Dec.	0	0
Total	55,700	54,700

EXAMPLE USE OF SIMULATED WATER-SUPPLY OPERATIONS

The Arkansas River basin model is designed to simulate future or hypothetical changes in hydrologic conditions or water-supply operations. Although the model is conceptually simple, the number of computations made and the interrelation among so many of the activities enable a complete analysis of the effects of possible changes. An example management consideration was selected to demonstrate the capabilities of the model and to indicate the total integrated effects of making such changes.

To demonstrate the use of the model as a management tool, several simulations were made so that the effects of a possible enlargement of Pueblo Reservoir could be considered. The first alternative selected, which was to be used as a baseline for comparison, used the 1975-85 calibrated basin-description and water-user files with the 1940-85 hydrologic precipitation and tributary streamflow time-series data. For this simulation period, the average annual inflow to Pueblo Reservoir included 53,400 acre-feet of transmountain imports, 7,500 acre-feet of native storage diversions, and 58,200 acre-feet of winter-water program storage, as listed in table 9. Basinwide direct diversions averaged 941,000 acre-feet annually; ground-water pumpage averaged 139,000 acre-feet annually; and reservoir releases averaged 272,000 acre-feet. Average streamflow at node 1375, ARK COOL, was 259 cubic feet per second. The monthly reservoir contents for reservoir 993, PUEBLO R, are shown in figure 27*A*. The hydrologic conditions of 1942 were very wet, and the simulated reservoir was filled during that year.

Table 9.--*Summary of six alternatives chosen to consider effects of enlarging Pueblo Reservoir, based on hydrologic conditions of 1940-85*

[All values are annual averages; inflows, reservoir contents, and basinwide usage values in thousands of acre-feet; discharge in cubic feet per second; concentration in milligrams per liter]

Alternative[1]	Inflows to Pueblo Reservoir			Average Pueblo Reservoir contents	Basinwide usage		
	Transmountain imports	Native storage diversion	Winter-water storage		Direct diversions	Ground-water pumpage	Reservoir releases
1	53.4	7.5	58.2	101	941	139	272
2	55.9	8.3	58.3	109	941	139	276
3	53.0	7.9	58.5	103	953	135	277
4	55.5	8.8	58.6	111	953	134	281
5	27.6	7.2	57.8	212	938	139	237
6	29.6	8.1	58.0	244	939	139	239

Alternative[1]	Streamflow information							
	960, ARK CANC		994, ARK PUBL		1095, ARK AVON		1375, ARK COOL	
	Discharge	Dissolved solids concentration	Discharge	Dissolved solids concentration	Discharge	Dissolved solids concentration	Discharge	Dissolved solids concentration
1	801	129	749	196	937	359	259	2,320
2	805	129	752	195	940	358	260	2,320
3	800	129	748	196	966	398	265	2,380
4	804	129	751	195	968	397	265	2,370
5	764	133	714	204	901	373	253	2,380
6	767	132	717	203	904	371	253	2,370

[1]Alternative 1 used the 1975-85 calibrated data. Alternative 2 was the same as alternative 1 except it included data for an enlarged Pueblo Reservoir. Alternative 3 used the 1975-85 calibrated data but added 30 cubic feet per second to the monthly flows of Fountain Creek. Alternative 4 was the same as alternative 3 except it included data for an enlarged Pueblo Reservoir. Alternative 5 used the 1975-85 calibrated data but user 999, FONT VLY, stored its Fryingpan-Arkansas project water in Pueblo Reservoir. Alternative 6 was the same as alternative 5 except it included data for an enlarged Pueblo Reservoir.

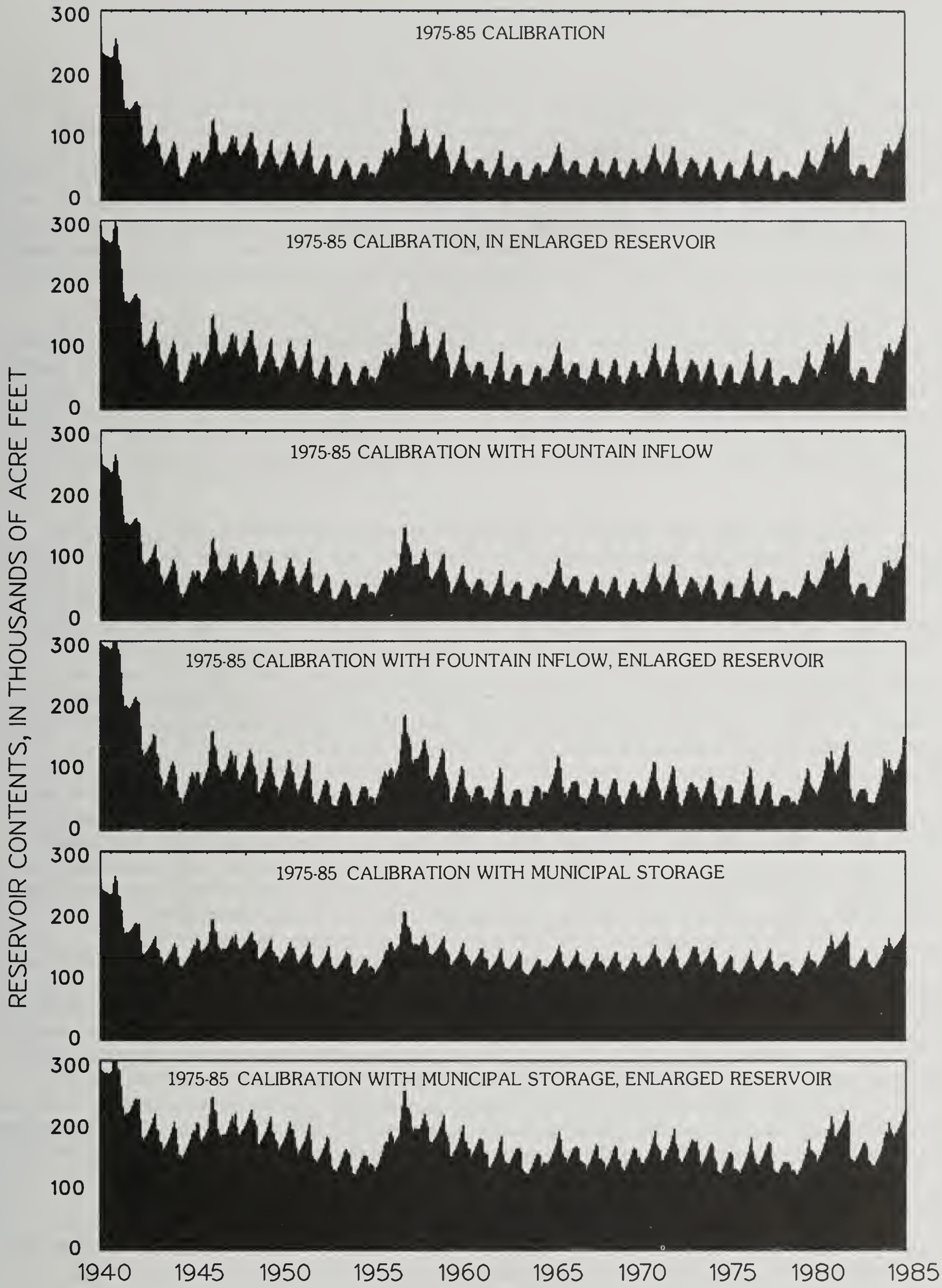

Figure 27.--Simulated reservoir content for six alternatives for reservoir 993, PUEBLO R, 1940-85.

As a second alternative, the same basin-description and water-user files were used except that the storage capacity of the conservation pool for Pueblo Reservoir was increased 40,000 acre-feet from 264,000 acre-feet to 304,000 acre-feet. The average annual inflows to Pueblo Reservoir for the second alternative indicated a 2,500-acre-foot increase in transmountain imports to 55,900 acre-feet (table 9), an 800-acre-foot increase in native storage diversions to 8,300 acre-feet, and a slight increase in winter-water storage. Basinwide water use remained the same except that reservoir releases increased 4,000 acre-feet. No significant change occurred in streamflow leaving the basin.

A noticeable factor that could affect the need for an enlarged reservoir is the recent increase in streamflow in Fountain Creek because of additional return flows of transmountain imports by the city of Colorado Springs. To consider the possible effects of increased return flow in Fountain Creek, two additional simulations were made that were similar to the first two, except that 30 cubic feet per second were added to every monthly flow of Fountain Creek.

When the third alternative is compared to the first alternative, the additional flow from Fountain Creek had minimal effect on Pueblo Reservoir. Transmountain imports decreased by 400 acre-feet, while native storage diversions increased by 400 acre-feet. Winter-water storage increased slightly. The most noticeable change caused by the additional inflow was the flow just downstream from Fountain Creek at node 1095, ARK AVON, where streamflow increased by about 30 cubic feet per second and dissolved-solids concentration increased by 40 milligrams per liter. This additional flow contributed to about 12,000 acre-feet of additional direct diversions and 5,000 acre-feet of additional reservoir releases.

The fourth alternative used the same data as did the third alternative except that data for an enlarged Pueblo Reservoir were used. The change in inflow to Pueblo Reservoir was almost the same as the change indicated when the second alternative is compared to the first alternative: Transmountain imports increased by 2,500 acre-feet; native storage diversions increased by 900 acre-feet; and winter-water storage increased by 100 acre-feet.

As discussed in the "Model Calibration of Simulated Water-Supply Operations" section (page 23), municipal storage can have a large effect on the contents of Pueblo Reservoir. The fifth alternative enabled user 999, FONT VLY to store water in Pueblo Reservoir rather than to export the water from the basin. When the fifth alternative is compared to the first alternative, major effects are evident. Transmountain imports decreased to 27,600 acre-feet, although lesser decreases occurred for native storage diversions (7,200 acre-feet) and for winter-water storage (57,800 acre-feet). Streamflow in the upper basin decreased because smaller transmountain imports were being delivered to Pueblo Reservoir.

The sixth alternative used the same data as did the fifth alternative except that data for an enlarged Pueblo Reservoir were used. When the sixth alternative is compared to alternative five, results are very similar to the two previous simulations that increased the capacity of Pueblo Reservoir: Transmountain imports increased by 2,000 acre-feet; native storage diversions increased by 900 acre-feet; winter-water storage increased by 200 acre-feet.

SUMMARY

An interactive-accounting model was used to simulate dissolved solids, streamflow, and water-supply operations in the Arkansas River basin, Colorado. A description of the generic river basin model and much of the data description and analysis necessary to apply the model to the Arkansas River basin have been documented in other reports. This report describes the calibration of the model within the Arkansas River basin and provides examples of uses of this calibrated model.

The model was first used to calibrate specific conductance to streamflow relations at three sites in the basin where observed monthly dissolved-solids loads were determined by using daily specific-conductance data. Simulated results indicated that existing log-log coefficients calculated by using instantaneous values were acceptable for the monthly time-step simulations at two of the three nodes, which accounted for most of the basin. This calibrated model then was used to compute dissolved-solids loads throughout the basin by using observed streamflow.

The model was calibrated for the 1940-85 period simulating streamflow only; all of the water-supply operations in the basin were incorporated in the regression relations for incremental streamflow. Coefficients of determination for 20 node locations ranged from 0.89 to 0.58, and values in excess of 0.80 were determined for 16 of the node locations.

The model input then was revised to incorporate 74 water users and 11 reservoirs to simulate the water-supply operations in the basin. Two periods were used for calibration: the 1943-74 period, which included John Martin Reservoir, and the 1975-85 period, which also included the Fryingpan-Arkansas project with Pueblo Reservoir. For the 1943-74 calibration, coefficients of determination for streamflow at 13 node locations ranged from 0.87 to 0.02. Simulation of the water-supply operations resulted in coefficients of determination that ranged from 0.87 to negative for irrigation diversions of the 37 water users with sufficient observed record for calibration. Even for those users whose simulated diversions did not relate well statistically to observed diversions, plots of data generally indicated reasonable model results. Calibration of reservoir contents did not include statistical measures, but again plots of data indicated reasonable similarity to observed values. Calibration for 1975-85 was not evaluated statistically, but average values and plots of reservoir contents indicated reasonableness of the simulation.

To demonstrate the utility of the model, six alternatives were simulated to consider the effects of potential enlargement of Pueblo Reservoir. The model was used to simulate a 46-year period that represented hydrologic conditions of 1940-85, with three major alternatives: the 1975-85 calibrated data; the 1975-85 calibrated data with an increase in Fountain Creek flows of 30 cubic feet per second; and the 1975-85 calibrated data with a municipal water user leaving Fryingpan-Arkansas project water in storage rather than diverting it. These three alternatives included the option of reservoir enlargement or no enlargement to give the six total alternatives. A 40,000-acre-foot enlargement of Pueblo Reservoir resulted in average increases of 2,500 acre-feet in transmountain diversions, of 800 acre-feet in storage diversions, and of 100 acre-feet in winter-water storage for all three of the management settings.

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SUPPLEMENTAL INFORMATION

Attachment A--*Basin-description file for dissolved-solids loads*

```
   OBSERVED ARKANSAS RIVER BASIN FLOW (with water-quality coefficients from Cain, 1987)
    29
     1000.       250.      1000.      2500.
812ARK LEAD        39.24     106.32  860          .10           .10          0.         -6.8          .64
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
                -3                     1.       740.       -.35
830HALFMOON        39.15     106.38  860        -.30           .05          0.          7.9          .50
                -4                     1.        98.       -.04
                -4                     1.        98.       -.04
                -4                     1.        98.       -.04
                -4                     1.        98.       -.04
                -4                     1.       150.       -.22
                -4                     1.       150.       -.22
                -4                     1.       150.       -.22
                -4                     1.       150.       -.22
                -4                     1.       150.       -.22
                -4                     1.        98.       -.04
                -4                     1.        98.       -.04
                -4                     1.        98.       -.04
845LAKE CK         39.05     106.37  860        -.55          -.10          0.         -6.8          .64
                -5                     1.        88.       -.16
                -5                     1.        88.       -.16
                -5                     1.        88.       -.16
                -5                     1.        88.       -.16
                -5                     1.        76.       -.13
                -5                     1.        76.       -.13
                -5                     1.        76.       -.13
                -5                     1.        76.       -.13
                -5                     1.        76.       -.13
                -5                     1.        88.       -.16
                -5                     1.        88.       -.16
                -5                     1.        88.       -.16
```

860ARK GRNT		39.02	106.25	915	.15	.10	0.	.2	.63
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
	-6			1.	426.	-.22			
865CLEAR CK		38.99	106.28	915	-.25	-.25	0.	7.9	.50
	-7			1.	87.	-.16			
	-7			1.	87.	-.16			
	-7			1.	87.	-.16			
	-7			1.	87.	-.16			
	-7			1.	75.	-.13			
	-7			1.	75.	-.13			
	-7			1.	75.	-.13			
	-7			1.	75.	-.13			
	-7			1.	75.	-.13			
	-7			1.	87.	-.16			
	-7			1.	87.	-.16			
	-7			1.	87.	-.16			
890COTTNWD		38.78	106.23	915	-.30	-.20	0.	7.9	.50
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
	-8			1.	240.	-.20			
915ARK SLID		38.51	105.98	937	-.05	.20	0.	-6.8	.64
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			
	-9			1.	2900.	-.43			

937ARK WELL	38.48	105.94	945	.20	.05	0.	-6.8	.64
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
-10			1.	2900.	-.43			
945ARK PARK	38.46	105.38	960	-.30	.20	0.	-6.8	.64
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1500.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
-11			1.	1700.	-.30			
950GRAPE CK	38.16	105.48	960	-.25	.15	0.	-6.8	.64
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1200.	-.32			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
-12			1.	1100.	-.30			
960ARK CANC	38.41	105.25	970	-.40	-.30	0.	-6.8	.64
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.26			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			
-13			1.	1200.	-.24			

970ARK PORT		38.37	105.02	994	-.40	-.30	0.	8.4	.61
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
	-14			1.	4100.	-.37			
991BEAVER C		38.36	104.95	994	.10	.00	0.	-248.2	.97
	-15			1.	1400.	-.30			
	-15			1.	1400.	-.30			
	-15			1.	1400.	-.30			
	-15			1.	1400.	-.30			
	-15			1.	1100.	-.30			
	-15			1.	1100.	-.30			
	-15			1.	1100.	-.30			
	-15			1.	1100.	-.30			
	-15			1.	1100.	-.30			
	-15			1.	1400.	-.30			
	-15			1.	1400.	-.30			
	-15			1.	1400.	-.30			
994ARK PUBL		38.25	104.65	1095	-.45	-.25	0.	-38.4	.75
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
	-16			1.	3000.	-.32			
1065FOUNT PB		38.31	104.61	1095	.10	.10	0.	-508.8	1.04
	-23			1.	3200.	-.17			
	-23			1.	3200.	-.17			
	-23			1.	3200.	-.17			
	-23			1.	3200.	-.17			
	-23			1.	2600.	-.17			
	-23			1.	2600.	-.17			
	-23			1.	2600.	-.17			
	-23			1.	2600.	-.17			
	-23			1.	2600.	-.17			
	-23			1.	3200.	-.17			
	-23			1.	3200.	-.17			
	-23			1.	3200.	-.17			

1090ST CHARL	38.20	104.51	1095	-.15	-.30	0.	-248.2	.97
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
-25		1.	3900.	-.29				
1095ARK AVON	38.23	104.40	1170	.05	.15	0.	-18.7	.69
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.31				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
-28		1.	4700.	-.27				
1160HUERF R	37.97	104.48	1170	.05	-.25	0.	-458.8	1.16
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
-29		1.	3900.	-.23				
1170ARK NPST	38.19	104.20	1197	.10	.10	0.	-71.0	.80
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
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-30		1.	2500.	-.22				
-30		1.	2500.	-.22				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				
-30		1.	2500.	-.17				

1195APISH R		38.07	103.99 1197		-.30	-.15	0.	-438.2	1.14
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
	-31		1.	3200.	-.27				
1197ARK CAT		38.12	103.91 1230		.15	.10	0.	-35.9	.74
	-32		1.	1200.	-.02				
	-32		1.	1200.	-.02				
	-32		1.	1200.	-.02				
	-32		1.	1200.	-.02				
	-32		1.	2800.	-.23				
	-32		1.	2800.	-.23				
	-32		1.	2800.	-.23				
	-32		1.	2800.	-.23				
	-32		1.	2800.	-.23				
	-32		1.	1200.	-.02				
	-32		1.	1200.	-.02				
	-32		1.	1200.	-.02				
1230ARK LAJU		37.98	103.53 1240		-.15	.20	0.	-189.3	.94
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.31				
	-33		1.	8300.	-.31				
	-33		1.	8300.	-.31				
	-33		1.	8300.	-.31				
	-33		1.	8300.	-.31				
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.29				
	-33		1.	8300.	-.29				
1240ARK ANMS		38.08	103.23 1305		.00	.15	0.	-231.8	.94
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.30				
	-34		1.	7100.	-.30				
	-34		1.	7100.	-.30				
	-34		1.	7100.	-.30				
	-34		1.	7100.	-.30				
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.24				
	-34		1.	7100.	-.24				

1285PURG ANS		37.99	103.26	1305	.05	-.25	0.	-385.0	1.06
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.21			
	-40			1.	4900.	-.21			
	-40			1.	4900.	-.21			
	-40			1.	4900.	-.21			
	-40			1.	4900.	-.21			
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.12			
	-40			1.	4900.	-.12			
1305ARK JM R		38.07	102.93	1330	.10	-.25	0.	-243.8	.97
	-41			1.	4100.	-.09			
	-41			1.	4100.	-.09			
	-41			1.	4100.	-.09			
	-41			1.	4100.	-.09			
	-41			1.	5900.	-.21			
	-41			1.	5900.	-.21			
	-41			1.	5900.	-.21			
	-41			1.	5900.	-.21			
	-41			1.	5900.	-.21			
	-41			1.	4100.	-.09			
	-41			1.	4100.	-.09			
	-41			1.	4100.	-.09			
1330ARK LAMR		38.12	102.63	1355	-.40	.15	0.	-222.3	.98
	-42			1.	8800.	-.16			
	-42			1.	8800.	-.16			
	-42			1.	8800.	-.16			
	-42			1.	8800.	-.16			
	-42			1.	6300.	-.24			
	-42			1.	6300.	-.24			
	-42			1.	6300.	-.24			
	-42			1.	6300.	-.24			
	-42			1.	6300.	-.24			
	-42			1.	8800.	-.16			
	-42			1.	8800.	-.16			
	-42			1.	8800.	-.16			
1341BIG SAND		38.13	102.49	1355	.08	.08	0.	-458.	1.16
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.15			
	-43			1.	5100.	-.15			
	-43			1.	5100.	-.15			
	-43			1.	5100.	-.15			
	-43			1.	5100.	-.15			
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.05			
	-43			1.	5100.	-.05			

1355ARK HOLY		38.07	102.12	1375	-.55	-.25	0.	-6.5	.92
	-44		1.	13000.	-.27				
	-44		1.	13000.	-.27				
	-44		1.	13000.	-.27				
	-44		1.	13000.	-.27				
	-44		1.	10000.	-.29				
	-44		1.	10000.	-.29				
	-44		1.	10000.	-.29				
	-44		1.	10000.	-.29				
	-44		1.	10000.	-.29				
	-44		1.	13000.	-.27				
	-44		1.	13000.	-.27				
	-44		1.	13000.	-.27				
1375ARK COOL		38.05	102.02	-999	.10	.10	0.	-6.5	.92
	-45		1.	13000.	-.27				
	-45		1.	13000.	-.27				
	-45		1.	13000.	-.27				
	-45		1.	13000.	-.27				
	-45		1.	10000.	-.29				
	-45		1.	10000.	-.29				
	-45		1.	10000.	-.29				
	-45		1.	10000.	-.29				
	-45		1.	10000.	-.29				
	-45		1.	13000.	-.27				
	-45		1.	13000.	-.27				
	-45		1.	13000.	-.27				

Attachment B--*Basin-description file for streamflow-only calibration*

```
     CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW
   28
 1000.     250.      1000.     2500.
812ARK LEAD  39.24     106.32      860       .10       .10         0.        -6.8       .64
             110       14.4      .019      725.     -.35
             110       14.2      .012      725.     -.35
             110       14.7      .009      725.     -.35
             123     .00947      2.15      725.     -.35
             113       69.8      .277      725.     -.35
             113       17.7      1.05      725.     -.35
             113       3.25      1.32      725.     -.35
             113       8.85      .683      725.     -.35
             113       9.66      .452      725.     -.35
             110       27.4      .050      725.     -.35
             110       21.2      .044      725.     -.35
             110       16.8      .011      725.     -.35
830HALFMOON  39.15     106.38      860      -.30       .05         0.         7.9       .50
             110       4.07      .019       98.     -.04
             110       3.73      .012       98.     -.04
             110       3.62      .009       98.     -.04
             123     .00217      2.15       98.     -.04
             113       19.9      .277      133.     -.22
             113       6.25      1.05      133.     -.22
             113       1.88      1.32      133.     -.22
             113       5.06      .683      133.     -.22
             113       4.90      .452      133.     -.22
             110       11.4      .050       98.     -.04
             110       7.73      .044       98.     -.04
             110       5.32      .011       98.     -.04
845LAKE CK   39.05     106.37      860      -.55      -.10         0.        -6.8       .64
             110       19.3      .019       85.      -.16
             110       15.0      .012       85.      -.16
             110       14.7      .009       85.      -.16
             123      .0105      2.15       85.      -.16
             113       142.      .277       76.      -.13
             113       42.3      1.05       76.      -.13
             113       9.31      1.32       76.      -.13
             113       19.2      .683       76.      -.13
             113       19.0      .452       76.      -.13
             110       47.2      .050       85.      -.16
             110       29.4      .044       85.      -.16
             110       20.6      .011       85.      -.16
```

860ARK GRNT	39.02	106.25	915	.15	.10	-11.	.2	.63
	110	75.7	.0836	421.	-.23			
	110	67.3	-.139	421.	-.23			
	23	-21.6	3.33	421.	-.23			
	23	-689.	21.4	421.	-.23			
	23	-1724.	38.1	2780.	-.48			
	13	446.	-26.1	2780.	-.48			
	13	64.0	16.9	2780.	-.48			
	13	137.	13.9	2780.	-.48			
	23	1457.	-23.2	2780.	-.48			
	23	371.	-6.13	421.	-.23			
	110	92.2	.117	421.	-.23			
	110	75.1	.141	421.	-.23			
865CLEAR CK	38.99	106.28	915	-.25	-.25	0.	7.9	.50
	110	12.4	.019	87.	-.16			
	110	11.4	.012	87.	-.16			
	110	11.2	.009	87.	-.16			
	123	.00601	2.15	87.	-.16			
	113	49.3	.277	74.	-.13			
	113	14.5	1.05	74.	-.13			
	113	3.81	1.32	74.	-.13			
	113	10.2	.683	74.	-.13			
	113	11.7	.452	74.	-.13			
	110	31.1	.050	87.	-.16			
	110	20.6	.044	87.	-.16			
	110	15.1	.011	87.	-.16			
890COTTNWD	38.78	106.23	915	-.30	-.20	0.	7.9	.50
	110	23.1	.019	240.	-.20			
	110	20.7	.012	240.	-.20			
	110	19.1	.009	240.	-.20			
	123	.00732	2.15	240.	-.20			
	113	31.0	.277	238.	-.20			
	113	8.71	1.05	238.	-.20			
	113	2.42	1.32	238.	-.20			
	113	8.51	.683	238.	-.20			
	113	12.0	.452	238.	-.20			
	110	36.5	.050	240.	-.20			
	110	30.5	.044	240.	-.20			
	110	25.5	.011	240.	-.20			
915ARK SLID	38.51	105.98	937	.10	.15	-5.	-6.8	.64
	109	82.9	-.0923	1115.	-.20			
	109	91.7	.0488	1115.	-.20			
	23	191.	-3.63	1115.	-.20			
	13	-181.	13.6	1115.	-.20			
	11	-109.	36.6	9800.	-.64			
	11	48.0	26.0	9800.	-.64			
	11	-242.	82.7	9800.	-.64			
	11	-12.2	30.7	9800.	-.64			
	11	22.2	15.3	9800.	-.64			
	23	403.	-6.40	1115.	-.20			
	109	115.	-.0813	1115.	-.20			
	109	119.	.0278	1115.	-.20			

937ARK WELL	38.48	105.94	945	.15	.05	1.	-6.8	.64
	23	91.6	-.397	300.	-.18			
	23	30.0	2.14	300.	-.18			
	23	-17.6	2.68	300.	-.18			
	13	-21.3	3.41	300.	-.18			
	23	-4103.	83.6	135.	-.13			
	23	-2353.	42.6	135.	-.13			
	9	-59.9	113.	135.	-.13			
	9	19.3	39.0	135.	-.13			
	9	-61.7	136.	135.	-.13			
	9	28.0	44.5	300.	-.18			
	23	322.	-6.74	300.	-.18			
	23	-31.4	4.88	300.	-.18			
945ARK PARK	38.46	105.38	960	-.40	.10	0.	-6.8	.64
	9	44.1	29.6	87.	-.16			
	9	34.6	14.7	87.	-.16			
	9	40.1	12.2	87.	-.16			
	201	288.	-.584	87.	-.16			
	13	-288.	23.6	75.	-.13			
	13	-375.	35.5	75.	-.13			
	24	-2729.	38.3	75.	-.13			
	24	-912.	13.7	75.	-.13			
	13	-35.8	5.62	75.	-.13			
	9	58.8	-24.1	87.	-.16			
	9	59.3	-39.4	87.	-.16			
	24	-64.2	2.90	87.	-.16			
950GRAPE CK	38.16	105.48	960	-.20	.15	0.	-6.8	.64
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1500.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
	-15	0.	1.	1700.	-.30			
960ARK CANC	38.41	105.25	970	-.10	-.30	0.	-6.2	.64
	201	277.	-.893	1400.	-.30			
	201	-455.	1.11	1400.	-.30			
	2	-97.0	33.7	1400.	-.30			
	24	-1174.	20.9	1400.	-.30			
	201	137.	-.267	1100.	-.30			
	2	-379.	146.	1100.	-.30			
	2	-552.	208.	1100.	-.30			
	2	-334.	120.	1100.	-.30			
	2	-51.7	-78.8	1100.	-.30			
	9	-161.	45.8	1400.	-.30			
	9	-128.	56.6	1400.	-.30			
	201	222.	-.704	1400.	-.30			

970ARK PORT	38.37	105.02	994	-.20	-.30	0.	8.4	.61
	201	-4891.	14.7	1400.	-.30			
	201	-298.	.833	1400.	-.30			
	2	-54.5	38.4	1400.	-.30			
	7	-191.	178.	1400.	-.30			
	14	-42.9	32.9	1100.	-.30			
	14	-267.	80.7	1100.	-.30			
	2	376.	-179.	1100.	-.30			
	24	-3250.	45.1	1100.	-.30			
	24	-2138.	32.6	1100.	-.30			
	7	-45.3	92.2	1400.	-.30			
	201	-258.	.707	1400.	-.30			
	7	-57.0	106.	1400.	-.30			
991BEAVER C	38.36	104.95	994	.10	.05	0.	-248.2	.97
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1100.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
	-16	0.	1.	1400.	-.30			
994ARK PUBL	38.25	104.65	1095	-.25	-.30	0.	-38.4	.75
	201	180.	-.733	1400.	-.30			
	7	-92.6	121.	1400.	-.30			
	27	133.	-5.27	1400.	-.30			
	201	-107.	.205	1400.	-.30			
	2	-168.	54.7	1100.	-.30			
	12	586.	-61.3	1100.	-.30			
	2	-507.	182.	1100.	-.30			
	27	4213.	-57.3	1100.	-.30			
	27	1124.	-17.9	1100.	-.30			
	7	-42.3	-43.6	1100.	-.30			
	27	-474.	10.1	1400.	-.30			
	7	-28.6	-116.	1400.	-.30			
1065FOUNT PB	38.26	104.61	1095	.10	.10	0.	-508.8	1.04
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	2600.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			
	-17		1.	3200.	-.17			

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1090ST CHARL  38.20     104.51     1095       -.10       -.25        0.    -248.2       .97
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
             -18                  1.      3900.     -.29
1095ARK AVON  38.23     104.40     1170        .10        .10        0.     -18.7       .69
             201     -945.      3.95      3200.     -.17
               7      130.     -79.4      3200.     -.17
               7      171.     -43.9      3200.     -.17
             201     -21.6      .334      3200.     -.17
               3      226.     -83.3      2600.     -.17
               7     -243.      220.      2600.     -.17
             201      413.     -.174      2600.     -.17
             201     -433.      .593      2600.     -.17
              27    -1027.      17.8      2600.     -.17
               7      96.7      44.1      3200.     -.17
             201     -308.      1.40      3200.     -.17
             201    -1431.      5.67      3200.     -.17
1160HUERF R   37.97     104.48     1170        .10       -.15        0.    -458.8      1.16
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
             -19                  1.      3900.    -.23
1170ARK NPST  38.19     104.20     1197        .10        .15        0.     -71.0       .80
               3      2.55     -95.1      3200.      -.27
              13     -123.      6.08      3200.      -.27
             201     -247.      .418      3200.      -.27
               7     -50.4     -106.      3200.      -.27
             201     -834.      .372      3200.      -.27
              12      26.0     -34.2      3200.      -.27
             201    -1108.      .375      3200.      -.27
              13      205.     -37.3      3200.      -.27
              28     1873.     -31.7      3200.      -.27
               3     -66.3     -103.      3200.      -.27
             201      95.0     -.357      3200.      -.27
             201     -69.1     .0311      3200.      -.27
```

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1195APISH R   38.07      103.99      1197        -.30        -.15          0.     -438.2       1.14
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
              -20                     1.      3200.     -.27
1197ARK CAT   38.12      103.91      1230         .15         .10          0.      -35.9        .74
              201       131.     -.356    3200.       -.27
               13       73.0     -6.63    3200.       -.27
              201       76.0     -.283    3200.       -.27
               28      2289.     -43.8    3200.       -.27
              201      -63.4     -.150    3200.       -.27
                8      -61.0     -50.0    3200.       -.27
              201       335.     -.319    3200.       -.27
                8      -115.      123.    3200.       -.27
                8      -26.7      69.0    3200.       -.27
                8      -63.9      107.    3200.       -.27
              201      -198.      .364    3200.       -.27
               28       153.     -5.53    3200.       -.27
1230ARK LAJU  37.98      103.53      1240        -.15         .20          0.     -189.3        .94
              128      -135.      .239    3200.       -.27
              201      -44.4     -.685    3200.       -.27
              128     -7450.     -.893    3200.       -.27
               28     -2755.      43.4    3200.       -.27
               14      -386.     -53.3    3200.       -.27
               14      -987.     -50.0    3200.       -.27
              106      -666.      .350    3200.       -.27
              201      -280.     -.421    3200.       -.27
              201       0.61     -.750    3200.       -.27
              201       55.3     -.773    3200.       -.27
              201       10.1     -.786    3200.       -.27
              201      -98.4     -.523    3200.       -.27
1240ARK ANMS  38.08      103.23      1305         .00         .15          0.     -231.8        .94
              201       9.40      .242    3200.     -.27
               26       233.     -5.79    3200.     -.27
               26       251.     -5.79    3200.     -.27
              201      -129.      .131    3200.     -.27
              201      -875.      .724    3200.     -.27
                6      -364.      142.    3200.     -.27
              201       66.4     -.260    3200.     -.27
               13      -272.      11.7    3200.     -.27
               13       78.3     -6.06    3200.     -.27
              201      -84.3      .313    3200.     -.27
              201      -78.4      .823    3200.     -.27
                8      -5.87      67.7    3200.     -.27
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1285PURG ANS  38.03     103.21     1305        .05       -.25         0.    -385.0       1.06
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.21
             -21                   1.     4900.     -.21
             -21                   1.     4900.     -.21
             -21                   1.     4900.     -.21
             -21                   1.     4900.     -.21
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.12
             -21                   1.     4900.     -.12
1305ARK JM R  38.07     102.93     1330        .00        .15         0.    -243.8        .97
             201     -90.0      -.389     4900.     -.12
               8     -69.9      -116.     4900.     -.12
             201      13.0      -1.30     4900.     -.12
             201      202.       .534     4900.     -.12
               6     1524.      -900.     4900.     -.21
               8      779.      -925.     4900.     -.21
             201      213.      -.450     4900.     -.21
               8      326.      -115.     4900.     -.21
               6      274.      -61.3     4900.     -.21
               6      109.      -54.0     4900.     -.12
               8     -26.3      -54.4     4900.     -.12
               6     -82.4      -36.3     4900.     -.12
1330ARK LAMR  38.12     102.63     1375       -.05        .15         0.    -222.3        .98
             201      3.94       .318     4900.     -.12
              25      161.      -4.57     4900.     -.12
             201      20.2      -.773     4900.     -.12
              14      87.0      -40.0     4900.     -.12
             201     -235.      -.257     4900.     -.21
             201      151.      -.700     4900.     -.21
             201      29.0      -.625     4900.     -.21
             201     -119.      -.389     4900.     -.21
              14     -329.       9.66     4900.     -.21
               5     -174.       25.3     4900.     -.12
               5     -45.0       17.6     4900.     -.12
              25      60.6      -1.99     4900.     -.12
1341BIG SAND  38.13     102.49     1375        .08        .08         0.      -6.8       1.16
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.15
             -22                   1.     5100.     -.15
             -22                   1.     5100.     -.15
             -22                   1.     5100.     -.15
             -22                   1.     5100.     -.15
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.05
             -22                   1.     5100.     -.05
```

1375ARK COOL	38.05	102.02	-999	.10	.10	0.	-6.5	.92
	4	10.4	127.	5100.	-.05			
	4	41.3	90.5	5100.	-.05			
	201	-39.6	4.06	5100.	-.05			
	201	141.	-.641	5100.	-.05			
	201	267.	-1.00	5100.	-.15			
	4	-1298.	475.	5100.	-.15			
	4	-101.	50.0	5100.	-.15			
	201	-33.3	.316	5100.	-.15			
	25	1780.	-25.4	5100.	-.15			
	5	98.7	-34.6	5100.	-.05			
	201	78.9	-.692	5100.	-.05			
	201	59.1	.207	5100.	-.05			

Attachment C--*Basin-description file for model calibration, 1943-74*

```
CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW
    40
 1000.     250.       1000.     2500.
90615COLUMBIN       39.2500  106.6000 -999       -.50       .32        0.        0.        .65
              110      0.0        .019     200.       -.05
              110      0.0        .012     200.       -.05
              110      0.0        .009     200.       -.05
              123      0.0        2.15     200.       -.05
              113      1.7        .277     800.       -.20
              113      0.65       1.05     800.       -.20
              113      0.08       1.32     800.       -.20
              113      0.12       .683     800.       -.20
              113      0.0        .452     800.       -.20
              110      0.0        .050     200.       -.05
              110      0.0        .044     200.       -.05
              110      0.0        .011     200.       -.05
90620EWING          39.2600  106.6100 -999       -.55       .44        0.        0.        .65
              110      0.25       .019     200.       -.05
              110      0.22       .012     200.       -.05
              110      0.26       .009     200.       -.05
              123     .0001       2.15     200.       -.05
              113      1.9        .277     800.       -.20
              113      0.41       1.05     800.       -.20
              113      0.07       1.32     800.       -.20
              113      0.18       .683     800.       -.20
              113      0.20       .452     800.       -.20
              110      0.54       .050     200.       -.05
              110      0.33       .044     200.       -.05
              110      0.26       .011     200.       -.05
90625WURTZ          39.2400  106.5900 -999       -.45       .20        0.        0.        .65
              110      0.0        .019     200.       -.05
              110      0.0        .012     200.       -.05
              110      0.0        .009     200.       -.05
              123      0.0        2.15     200.       -.05
              113      5.4        .277     800.       -.20
              113      1.0        1.05     800.       -.20
              113      0.11       1.32     800.       -.20
              113      0.24       .683     800.       -.20
              113      0.03       .452     800.       -.20
              110      0.0        .050     200.       -.05
              110      0.0        .044     200.       -.05
              110      0.0        .011     200.       -.05
```

90775BUSK-IVH	39.2000	106.8000	-999	-.70	.10	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.03	.009	200.	-.05				
123	.0006	2.15	200.	-.05				
113	6.6	.277	400.	-.20				
113	2.1	1.05	400.	-.20				
113	0.36	1.32	400.	-.20				
113	0.66	.683	400.	-.20				
113	0.43	.452	400.	-.20				
110	1.8	.050	200.	-.05				
110	0.42	.044	200.	-.05				
110	0.0	.011	200.	-.05				
90730TW LK TN	39.1500	106.9000	-999	-.70	.05	0.	0.	.65
110	2.9	.019	200.	-.05				
110	2.5	.012	200.	-.05				
110	2.3	.009	200.	-.05				
123	.0020	2.15	200.	-.05				
113	58.	.277	400.	-.20				
113	15.	1.05	400.	-.20				
113	3.1	1.32	400.	-.20				
113	5.5	.683	400.	-.20				
113	4.3	.452	400.	-.20				
110	9.5	.050	200.	-.05				
110	9.5	.044	200.	-.05				
110	3.5	.011	200.	-.05				
91150LARKSPUR	39.1000	107.0000	-999	-.70	0.0	0.	0.	.65
110	0.0	.019	200.	-.05				
110	0.0	.012	200.	-.05				
110	0.0	.009	200.	-.05				
123	0.0	2.15	200.	-.05				
113	0.24	.277	800.	-.20				
113	0.080	1.05	800.	-.20				
113	0.013	1.32	800.	-.20				
113	0.053	.683	800.	-.20				
113	0.10	.452	800.	-.20				
110	0.0	.050	200.	-.05				
110	0.0	.044	200.	-.05				
110	0.0	.011	200.	-.05				
812ARK LEAD	39.26	106.34	860	.10	-.05	0.	-6.8	.64
110	13.8	.019	740.	-.35				
110	13.8	.012	740.	-.35				
110	14.6	.009	740.	-.35				
123	.00967	2.15	740.	-.35				
113	76.7	.277	740.	-.35				
113	16.6	1.05	740.	-.35				
113	3.13	1.32	740.	-.35				
113	7.18	.683	740.	-.35				
113	8.27	.452	740.	-.35				
110	25.7	.050	740.	-.35				
110	19.7	.044	740.	-.35				
110	14.9	.011	740.	-.35				

```
  820LAKE FK      39.26    106.45    825      -.13       .18        0.        0.        .65
            110      2.35      .019     100.      -.05
            110      2.07      .012     100.      -.05
            110      1.95      .009     100.      -.05
            123    .00109      2.15     100.      -.05
            113      12.3      .277     250.      -.20
            113      5.79      1.05     250.      -.20
            113      1.74      1.32     250.      -.20
            113      3.03      .683     250.      -.20
            113      2.85      .452     250.      -.20
            110      6.23      .050     100.      -.05
            110      4.07      .044     100.      -.05
            110      3.10      .011     100.      -.05
825LAKE FK      39.2528  106.3739  860       .15       .16        0.        0.        .65
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
830HALFMOON     39.15    106.38    860      -.42      -.10        0.       7.9        .50
            110      4.01      .019      98.      -.04
            110      3.66      .012      98.      -.04
            110      3.52      .009      98.      -.04
            123    .00211      2.15      98.      -.04
            113      19.9      .277     150.      -.22
            113      5.99      1.05     150.      -.22
            113      1.77      1.32     150.      -.22
            113      4.68      .683     150.      -.22
            113      4.63      .452     150.      -.22
            110      10.9      .050      98.      -.04
            110      7.48      .044      98.      -.04
            110      5.12      .011      98.      -.04
845LAKE CK      39.05    106.37    855      -.50      -.10        0.      -6.8        .64
            110      11.3      .019      88.      -.16
            110      10.2      .012      88.      -.16
            110      10.0      .009      88.      -.16
            123     .0071      2.15      88.      -.16
            113      100.      .277     100.      -.13
            113      29.5      1.05     100.      -.13
            113      6.36      1.32     100.      -.13
            113      12.6      .683     100.      -.13
            113      12.7      .452     100.      -.13
            110      31.4      .050      88.      -.16
            110      19.9      .044      88.      -.16
            110      14.0      .011      88.      -.16
```

855LAKE CK	39.0807	106.3125	860	.15	.18	0.	0.	00.0	
	1								
	1								
	1								
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	1								
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	1								
	1								
	1								
860ARK GRNT	39.04	106.24	915	.13	0.	0.	.2	.63	
110	66.0	.019	426.	-.22					
110	67.5	.012	426.	-.22					
110	74.9	.009	426.	-.22					
123	.079	2.15	426.	-.22					
113	87.4	.277	426.	-.22					
113	6.70	1.05	426.	-.22					
113	4.50	1.32	426.	-.22					
113	31.9	.683	426.	-.22					
113	31.0	.452	426.	-.22					
110	96.1	.050	426.	-.22					
110	84.3	.044	426.	-.22					
110	64.1	.011	426.	-.22					
865CLEAR CK	38.99	106.28	870	-.30	-.27	0.	7.9	.50	
110	13.2	.019	87.	-.16					
110	12.4	.012	87.	-.16					
110	12.2	.009	87.	-.16					
123	.00661	2.15	87.	-.16					
113	54.9	.277	250.	-.13					
113	15.7	1.05	250.	-.13					
113	4.16	1.32	250.	-.13					
113	10.6	.683	250.	-.13					
113	12.1	.452	250.	-.13					
110	32.9	.050	87.	-.16					
110	21.9	.044	87.	-.16					
110	16.1	.011	87.	-.16					
870CLEAR CK	38.99	106.2444	915	.10	-.20	0.	0.	00.0	
	1								
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	1								
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	1								
	1								
	1								
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	1								
	1								
	1								

890COTTNWD	38.78	106.23	915	-.30	-.30	0.	7.9	.50
	110	22.8	.019	240.	-.20			
	110	20.6	.012	240.	-.20			
	110	19.1	.009	240.	-.20			
	123	.00732	2.15	240.	-.20			
	113	31.6	.277	240.	-.20			
	113	8.60	1.05	240.	-.20			
	113	2.39	1.32	240.	-.20			
	113	8.32	.683	240.	-.20			
	113	11.6	.452	240.	-.20			
	110	36.5	.050	240.	-.20			
	110	30.5	.044	240.	-.20			
	110	25.4	.011	240.	-.20			
915ARK SLID	38.51	105.98	937	0.	.18	0.	-6.8	.64
	110	127.	.019	2900.	-.43			
	110	118.	.012	2900.	-.43			
	110	96.1	.009	2900.	-.43			
	123	.026	2.15	2900.	-.43			
	113	58.4	.277	2900.	-.43			
	113	9.25	1.05	2900.	-.43			
	112	.00027	5.00	2900.	-.43			
	113	24.9	.683	2900.	-.43			
	113	27.2	.452	2900.	-.43			
	110	118.	.050	2900.	-.43			
	110	154.	.044	2900.	-.43			
	110	135.	.011	2900.	-.43			
937ARK WELL	38.48	105.94	945	.15	0.	0.	-6.8	.64
	110	57.6	.019	2900.	-.43			
	110	54.5	.012	2900.	-.43			
	110	43.3	.009	2900.	-.43			
	123	.0055	2.15	2900.	-.43			
	113	33.0	.277	2900.	-.43			
	113	0.17	1.05	2900.	-.43			
	113	.378	1.32	2900.	-.43			
	113	5.28	.683	2900.	-.43			
	113	14.6	.452	2900.	-.43			
	110	47.2	.050	2900.	-.43			
	110	87.6	.044	2900.	-.43			
	110	71.1	.011	2900.	-.43			
945ARK PARK	38.46	105.38	960	-.40	.15	0.	-6.8	.64
	2	0.00	128.	1600.	-.30			
	2	0.00	119.	1600.	-.30			
	2	0.00	65.5	1600.	-.30			
	2	0.00	44.4	1600.	-.30			
	2	7.0	21.1	1600.	-.30			
	114	10.0	1.9	1600.	-.30			
	2	220.	10.0	1600.	-.30			
	2	0.00	47.2	1600.	-.30			
	2	0.00	7.33	1600.	-.30			
	2	0.00	30.0	1600.	-.30			
	2	0.00	48.6	1600.	-.30			
	2	0.00	103.	1600.	-.30			

950GRAPE CK	38.16	105.48	960	-.20	.15	0.	-6.8	.64
	15	0.	1.	1100.	-.30			
	15	0.	1.	1100.	-.30			
	15	0.	1.	1100.	-.30			
	15	0.	1.	1100.	-.30			
	15	0.	1.	1200.	-.32			
	15	0.	1.	1200.	-.32			
	15	0.	1.	1200.	-.32			
	15	0.	1.	1200.	-.32			
	15	0.	1.	1200.	-.32			
	15	0.	1.	1100.	-.30			
	15	0.	1.	1100.	-.30			
	15	0.	1.	1100.	-.30			
960ARK CANC	38.41	105.25	970	-.20	-.30	0.	-6.2	.64
	2	-43.	8.	1100.	-.24			
	2	-42.	18.	1100.	-.24			
	2	-48.	11.	1100.	-.24			
	2	-90.	23.6	1100.	-.24			
	2	-70.0	3.48	1300.	-.26			
	2	-200.	143.	1300.	-.26			
	2	-100.	11.5	1300.	-.26			
	102	.056	5.78	1300.	-.26			
	2	-70.	24.	1300.	-.26			
	2	-73.	13.9	1100.	-.24			
	2	-79.	11.	1100.	-.24			
	2	-47.	18.	1100.	-.24			
970ARK PORT	38.37	105.02	994	-.25	-.30	-1.	8.4	.61
	2	-43.	8.	4400.	-.37			
	2	-42.	18.	4400.	-.37			
	2	-48.	11.	4400.	-.37			
	2	-62.	5.	4400.	-.37			
	2	-36.	13.	4400.	-.37			
	2	-200.	90.0	4400.	-.37			
	2	-43.	8.	4400.	-.37			
	2	-21.	12.	4400.	-.37			
	2	-70.	24.	4400.	-.37			
	2	-73.	13.	4400.	-.37			
	2	-79.	11.	4400.	-.37			
	2	-47.	18.	4400.	-.37			
991BEAVER C	38.36	104.95	994	0.0	.15	0.	-248.2	.97
	16	0.	1.	3000.	-.30			
	16	0.	1.	3000.	-.30			
	16	0.	1.	3000.	-.30			
	16	0.	1.	3000.	-.30			
	16	0.	1.	2000.	-.30			
	16	0.	1.	2000.	-.30			
	16	0.	1.	2000.	-.30			
	16	0.	1.	2000.	-.30			
	16	0.	1.	2000.	-.30			
	16	0.	1.	3000.	-.30			
	16	0.	1.	3000.	-.30			
	16	0.	1.	3000.	-.30			

994ARK PUBL	38.25	104.65	1095	-.30	-.30	-1.	-38.4	.75
	7	17.0	288.	3000.	-.32			
	7	24.0	210.	3000.	-.32			
	7	-20.0	125.	3000.	-.32			
	7	-47.0	200.	3000.	-.32			
	7	159.	0.	3000.	-.32			
	7	-100.	250.	3000.	-.32			
	7	-82.0	75.5	3000.	-.32			
	7	-36.0	91.0	3000.	-.32			
	7	50.	50.0	3000.	-.32			
	7	-5.	130.	3000.	-.32			
	7	38.0	220.	3000.	-.32			
	7	42.0	220.	3000.	-.32			
1065FOUNT PB	38.26	104.61	1095	0.	.15	0.	-508.8	1.04
	17	0.	1.	5000.	-.17			
	17	0.	1.	5000.	-.17			
	17	0.	1.	5000.	-.17			
	17	0.	1.	5000.	-.17			
	17	0.	1.	4000.	-.17			
	17	0.	1.	4000.	-.17			
	17	0.	1.	4000.	-.17			
	17	0.	1.	4000.	-.17			
	17	0.	1.	4000.	-.17			
	17	0.	1.	5000.	-.17			
	17	0.	1.	5000.	-.17			
	17	0.	1.	5000.	-.17			
1090ST CHARL	38.20	104.51	1095	-.20	-.25	0.	-248.2	.97
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
	18	0.	1.	5000.	-.29			
1095ARK AVON	38.23	104.40	1170	.10	.15	-1.	-18.7	.69
	3	-2.	0.	4700.	-.27			
	3	0.	15.	4700.	-.27			
	3	0.	25.	4700.	-.27			
	3	-5.0	25.	4700.	-.27			
	3	-80.0	20.	4700.	-.31			
	3	-200.	50.	4700.	-.31			
	3	100.	20.	4700.	-.31			
	3	70.0	13.2	4700.	-.31			
	3	-14.2	45.	4700.	-.31			
	3	-1.7	40.	4700.	-.27			
	3	0.	30.	4700.	-.27			
	3	0.	7.	4700.	-.27			

```
1160HUERF R      37.97    104.48   1170        .10       -.15         0.    -458.8      1.16
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
             19         0.        1.     3900.      -.23
1170ARK NPST     38.19    104.20   1197        .15        .10        -1.     -71.0       .80
              3        23.        0.     2500.      -.17
              3        15.       60.     2500.      -.17
              3       -31.      100.     2500.      -.17
              3      -94.0       75.     2500.      -.17
              3      -32.0       40.     2500.      -.22
              3      -30.0      140.     2500.      -.22
              3      -150.       50.     2500.      -.22
              3       -80.     13.8      2500.      -.22
              3      -60.0      120.     2500.      -.22
              3      -55.0      150.     2500.      -.17
              3       -47.      110.     2500.      -.17
              3         0.       30.     2500.      -.17
1195APISH R      38.07    103.99   1197       -.50       -.25         0.    -438.2      1.14
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
             20         0.        1.     3200.      -.27
1197ARK CAT      38.12    103.91   1230        .10        .10         0.     -35.9       .74
              3       -30.        0.     1200.      -.02
              3       -16.        0.     1200.      -.02
              3        31.        0.     1200.      -.02
              3       25.0       4.8     1200.      -.02
            103        2.0       1.6     2800.      -.23
              3      -100.      16.2     2800.      -.23
              3       120.      14.2     2800.      -.23
              3       200.      13.8     2800.      -.23
              3       30.0      18.6     2800.      -.23
              3       50.0       3.3     1200.      -.02
              3        65.        0.     1200.      -.02
              3      -30.0        0.     1200.      -.02
```

1230ARK LAJU		37.98	103.53	1240	-.25	.20	-1.	-189.3	.94
	8	0.	0.	8300.	-.29				
	8	0.	0.	8300.	-.29				
	8	0.	0.	8300.	-.29				
	8	-7.3	6.1	8300.	-.29				
	108	18.	3.2	8300.	-.31				
	108	250.	1.3	8300.	-.31				
	8	-34.6	18.1	8300.	-.31				
	8	31.6	20.0	8300.	-.31				
	8	-20.6	22.4	8300.	-.31				
	8	-2.4	3.8	8300.	-.29				
	8	0.	0.	8300.	-.29				
	8	0.	0.	8300.	-.29				
1240ARK ANMS		38.08	103.23	1289	-.40	.15	-1.	-231.8	.94
	6	0.	0.	7100.	-.24				
	6	0.	0.	7100.	-.24				
	6	0.	0.	7100.	-.24				
	6	-7.3	6.4	7100.	-.24				
	6	-150.	11.9	7100.	-.30				
	6	-350.	20.3	7100.	-.30				
	6	-80.0	16.2	7100.	-.30				
	6	-31.6	20.3	7100.	-.30				
	6	-20.6	22.6	7100.	-.30				
	6	-2.4	3.4	7100.	-.24				
	6	0.	0.	7100.	-.24				
	6	0.	0.	7100.	-.24				
1285PURG ANS		38.03	103.21	1289	-.10	-.25	0.	-385.0	1.06
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.21				
	21	0.	1.	6000.	-.21				
	21	0.	1.	6000.	-.21				
	21	0.	1.	6000.	-.21				
	21	0.	1.	6000.	-.21				
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.12				
	21	0.	1.	6000.	-.12				
1289ARK A JM		38.07	103.15	1305	-.05	.15	0.	-243.8	.97
	5	0.	0.	4100.	-.09				
	5	0.	0.	4100.	-.09				
	5	0.	0.	4100.	-.09				
	5	-2.8	2.2	4100.	-.09				
	5	-9.3	3.8	5900.	-.21				
	5	-12.1	5.4	5900.	-.21				
	5	-13.3	5.9	5900.	-.21				
	5	-12.1	6.1	5900.	-.21				
	5	-7.9	7.1	5900.	-.21				
	5	-0.9	1.0	4100.	-.09				
	5	0.	0.	4100.	-.09				
	5	0.	0.	4100.	-.09				

Attachment C--*Basin-description file for model calibration, 1943-74*--Continued

1305ARK JM R		38.07	102.92	1330	.00	-.20	0.	-243.8	.97
	1								
	1								
	1								
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	1								
	1								
	1								
1330ARK LAMR		38.12	102.63	1355	-.35	.15	0.	-222.3	.98
	5	0.	0.	8800.	-.16				
	5	0.	0.	8800.	-.16				
	5	0.	0.	8800.	-.16				
	5	-50.	6.6	8800.	-.16				
	5	-200.	11.3	6300.	-.24				
	104	1.00	2.5	6300.	-.24				
	5	-130.	17.7	6300.	-.24				
	5	-25.0	18.5	6300.	-.24				
	5	-23.9	21.3	6300.	-.24				
	5	-2.8	3.2	8800.	-.16				
	5	0.	0.	8800.	-.16				
	5	0.	0.	8800.	-.16				
1341BIG SAND		38.13	102.49	1355	.08	.08	0.	-6.8	1.16
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
1355ARK HOLY		38.0436	102.1192	1375	-.30	-.25	0.	0.	00.0
	1								
	1								
	1								
	1								
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	1								
	1								
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	1								
	1								
	1								

Attachment C--*Basin-description file for model calibration, 1943-74*--Continued

1375ARK COOL	38.05	102.02	-999	-.05	.15	0.	-6.5	.92
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				
4	70.0	7.0	13000.	-.27				
104	23.0	2.10	10000.	-.29				
104	30.0	1.85	10000.	-.29				
4	30.0	20.0	10000.	-.29				
4	80.0	18.5	10000.	-.29				
4	35.0	19.4	10000.	-.29				
4	-2.9	2.7	13000.	-.27				
4	0.	0.	13000.	-.27				
4	0.	0.	13000.	-.27				

Attachment D--*Additional basin-description file for model calibration, 1943-74*

```
MAIN STEM RESERVOIRS (pre 1965) PLUS OTHER INITIAL DATA
PET     0.    0.    0.    0.12  0.40  0.52  0.57  0.52  0.34  0.04  0.    0.
EVAP    0.    0.    0.    0.75  0.95  1.00  1.10  0.85  0.60  0.50  0.10  0.
AGDMND  0.09  0.11  0.18  0.27  0.40  0.52  0.57  0.52  0.34  0.27  0.22  0.14
SESNAL  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00
AQUIFER .2    10000.
DRINK    .13
CONV FAC69.04853.310  1.38  1.55  1.25 104.0 104.7 .80  60.3   1.
   11
  824TURQUOIS    17731.   3000.    245.   106.3739    39.2528    13000.     100.  .10  .05
  854TWIN LKS    54453.   8000.   1100.   106.3125    39.0807    44000.      75. -.05  .05
  869CLR CK R    11440.            382.   106.2444    38.99       9000.     100. -.05  0.0
 1106LK HENRY    10300.           1120.   103.684     38.224      3500.    1000.  .20  .05
 1107MEREDITH    28000.           3220.   103.658     38.172                     -.05  .03
 1202DYE RES      4000.            800.   103.661     38.045                      .26 -.07
 1203HLBROK R     7000.            673.   103.580     38.029                     -.02  .02
 1221GR PLAIN   130000.          12653.   102.707     38.308                      .10  .05
 1236HRS CK R    28000.           2603.   103.372     38.144                     -.05 -.03
 1238ADB CK R    65000.           5147.   103.231     38.236                     -.05  .05
 1300JM RES     412000.          17500.   102.92      38.07      25000.    1000. -.08 -.05
```

```
GW01
GW02
GW03
GW04
GW05
GW06
GW07     5000. 200.
GW08
GW08a
GW09
GW10
GW11
GW12    10000. 100. 25000. 100.
GW13
GW14
GW15
GW16    20000. 100. 25000. 100.
GW17
GW18    20000. 125. 10000. 125.
GW19
GW20
GW21                60000. 200.
GW22
GW23    10000. 300. 10000. 400.
GW24
GW25
GW26    40000. 350. 15000. 500.
GW27
GW28    30000. 700. 80000. 700.
GW29
GW30    40000. 800. 7000001500.
GW31    100000 900.
GW32    50000.1000. 3000001500.
GW33
GW34    30000.1500. 1000001500.
GW35
GW36    60000.2000. 2000001500.
GW37
GW38    2000003000. 3000004000.
GW39    4000003500. 3000004000.
```

```
BASIN USERS IN 1965
   74
 1101MARTIN        1      240.        2.  106.3474   39.2422 0.16 0.08    10
                   1    1      0.20  106.3474   39.2422      800.
    1      3.43  106.338    39.2563
 1104BERRY         1      200.        2.  106.3604   39.2407 0.35-0.01    10
                   1    1      0.20  106.345    39.2407      800.
    1      4.00  106.335    39.2539
 1108WELL-STR      1       99.        2.  106.3566   39.2571-0.05-0.03    10
                   1    1      0.20  106.343    39.240       800.
    1      8.00  106.332    39.252
 1110BEAVER D      1      320.        2.  106.3497   39.2420 0.30-0.07    10
                   2    1      0.20  106.341    39 .239      800.
    1      5.71  106.329    39.2505
    1      1.43  106.329    39.2505
 1116YOUNGR 2      1      340.        2.  106.3601   39.2261-0.05 0.06    10
                   1    1      0.20  106.340    39.2261      800.
    1      6.29  106.326    39.2384
 1122DERRY 1       1      400.        2.  106.3285   39.1446 0.30-0.04    10
                   1    1      0.20  106.3285   39.1446      800.
    1      4.00  106.3258   39.1841
 1125UPPR RIV      1      600.        2.  106.3289   39.1822-0.05-0.02    10
                   1    1      0.20  106.3289   39.1822      800.
    1     14.00  106.3404   39.2008
 1128PIONEER       1      320.        2.  106.3202   39.1365-0.15-0.10    10
                   1    1      0.20  106.3202   39.1365      800.
    1      7.00  106.3156   39.1439
 1130WHEEL         1      200.        2.  106.3152   39.1338 0.25-0.14    10
                   1    1      0.20  106.3152   39.1338      800.
    1     16.00  106.3124   39.1379
 1131CHAMP         1      320.        2.  106.3208   39.1429-0.08-0.05    10
                   1    1      0.20  106.3208   39.1429      800.
    1      5.00  106.3157   39.1500
 1137LANGHOFF      1       80.        2.  106.2051   38.9731-0.05 0.0     10
                   1    1      0.20  106.2051   38.9731      800.
    1      4.80  106.2130   38.9869
 1140DRYFIELD      1       40.        2.  106.2036   38.9614 0.25-0.05    10
                   1    1      0.20  106.2036   38.9614      800.
    1      6.20  106.2049   38.9678
 1143RVRSD-AL      1      300.       5.0  106.1804   38.9098-0.05-0.05    10
                   4    1      0.20  106.1804   38.9098      800.
    1      8.00  106.1896   38.9463
    1      1.00  106.1896   38.9463
    1      9.00  106.1896   38.9463
    1     16.00  106.1896   38.9463
 1146HELENA        1      320.       6.0  106.1228   38.8094 0.28 0.03     1
                   3    1      0.20  106.1228   38.8094      800.
    1      1.00  106.1142   38.8331
    1     19.00  106.1142   38.8331
    1     16.00  106.1142   38.8331
 1147BV SMELT      4        0.        2.  106.4435   38.6588-0.05 0.05     0
                   1    2      1.00  106.4435   38.6588
    1    115.00  106.1216   38.8474
```

Attachment E--*Basin water-user file for model calibration, 1943-74*--Continued

```
1149BRY-ALEN       1       100.        2.  106.0750   38.7681-0.02 0.02    1
                   2    1       0.20  106.0750   38.7681       800.
   1      5.00  106.1033   38.8131
   1      6.00  106.1033   38.8131
1155SALIDA         1       900.        2.  106.0000   38.5597 0.23-0.09    9
                   1    1       0.20  106.0000   38.5597       800.
   1     20.00  106.0569   38.6153
1158KRAFT          1       240.        2.  106.0794   38.6000-0.03 0.04    9
                   1    1       0.20  106.0794   38.6000       800.
   1      5.00  106.0558   38.6197
1161SUNNY PK       1       700.        2.5  106.0393   38.5761 0.30 0.04    9
                   2    1       0.20  106.0393   38.5761       800.
   1     14.17  106.0670   38.6043
   1     25.00  106.0670   38.6043
1164BILL-HAM       1       534.        3.6  106.0038   38.5524-0.05 0.03    9
                   2    1       0.20  106.0038   38.5524       800.
   1     16.00  106.0787   38.5794
   1      1.00  106.0787   38.5794
1201PICKETT        1        90.        2.  105.8934   38.4826-0.03 0.02    2
                   1    1       0.20  105.8934   38.4826       800.
   1      3.80  105.9150   38.4968
1204PLEASANT       1       250.        3.9  105.8132   38.4381-0.05-0.01    2
                   2    1       0.20  105.8132   38.4381       800.
   1      2.00  105.8413   38.4592
   1      8.00  105.8413   38.4592
1210S CANON        1      1280.        4.8  105.2009   38.4306-0.05 0.12    2
                   8    1       0.20  105.2009   38.4306       800.
   1      2.00  105.2689   38.4319
   1      2.00  105.2689   38.4319
   1      3.00  105.2689   38.4319
   1      7.91  105.2689   38.4319
   1      1.00  105.2689   38.4319
   1      3.40  105.2689   38.4319
   1      3.00  105.2689   38.4319
   1     23.20  105.2689   38.4319
1213CANON WW       2       500.        2.  105.2253   38.4439-0.06 0.05    2
                   2    2       0.50  105.2253   38.4439
   1     19.00  105.2408   38.4376
   1      3.50  105.2408   38.4376
1215S C POWR       4      3300.        1.0  105.2230   38.4345  .30 0.07    0
                   3    2       1.00  105.2230   38.4345
   1     37.00  105.2287   38.4403
   1     15.00  105.2287   38.4403
   1      9.00  105.2287   38.4403
1216HYD-FRUT       1      4180.       -1.8  105.1968   38.4592 0.10 0.15    2
                   1    1       0.20  105.1968   38.4592       800.
   1     77.00  105.2521   38.4348
1219OIL CK         1      1250.       -2.9  105.1885   38.4461 0.32 0.00    2
                   2    1       0.20  105.1885   38.4461       800.
   1     10.46  105.2327   38.4403
   1     14.27  105.2327   38.4403
```

Attachment E--*Basin water-user file for model calibration, 1943-74*--Continued

```
1220FREMONT       1      425.       16.  105.1341   38.3967 0.25-0.07    2
                  4    1      0.20  105.1341   38.3967      800.
   1     17.00  105.1867   38.4272
   1      0.24  105.1867   38.4272
   1      0.28  105.1867   38.4272
   1      0.41  105.1867   38.4272
1222CF&I          3    41000.        1.  104.6250   38.2333 0.40-0.12    0
                  8    2      0.83  104.6250   38.2333
   1      2.00  105.1581   38.4145
   1     48.00  105.1581   38.4145
   1     20.00  105.1581   38.4145
   1      5.70  105.1581   38.4145
   1      1.64  105.1581   38.4145
   1    150.00  105.1581   38.4145
   1      0.    104.678    38.241
   3     150.   104.678    38.241             824
1225UNION         1     1250.        2.  105.1092   38.3934 0.15-0.13    2
                  1    1      0.50  105.1092   38.3934      800.
   1     48.00  105.1583   38.4144
1228HNNKRATT      1      125.       2.0  105.1238   38.4111 0.0  0.02    2
                  5    1      0.50  105.1238   38.4111      800.
   1      1.60  105.1480   38.4140
   1      1.00  105.1480   38.4140
   1      0.56  105.1480   38.4140
   1      1.00  105.1480   38.4140
   1      1.00  105.1480   38.4140
1231L ATTRBY      1      180.       2.2  105.0580   38.4029-0.05-0.03    2
                  3    1      0.50  105.0580   38.4029      800.
   1      3.50  105.0719   38.3921
   1      2.00  105.0719   38.3921
   1      3.60  105.0719   38.3921
1234IDEAL CM      3     1600.        1.  105.0078   38.3778-0.10 0.07    0
                  7    2      1.00  105.0078   38.3778
   1      1.05  105.0147   38.3877
   1      0.50  105.0147   38.3877
   1      1.50  105.0147   38.3877
   1      1.00  105.0147   38.3877
   1      2.00  105.0147   38.3877
   1     11.50  105.0147   38.3877
   1      3.50  105.0147   38.3877
1240 HOBSON       1                  2.  104.9255   38.3404 -.05   .05    7
                  2    1      0.50  104.9255   38.3404
   1      1.60  104.9455   38.3421
   1      4.40  104.9455   38.3421
```

```
1401BESSEMER      1    20000.       -1.0  104.5985   38.2296 .05 -0.16    7
                 15    1       0.20  104.5985   38.2296     1900.
   1       2.00  104.7263   38.2606
   1      20.00  104.7263   38.2606
   1       3.74  104.7263   38.2606
   1       3.00  104.7263   38.2606
   1       2.50  104.7263   38.2606
   1       5.13  104.7263   38.2606
   1       1.47  104.7263   38.2606
   1       3.40  104.7263   38.2606
   1       2.00  104.7263   38.2606
   1       3.00  104.7263   38.2606
   1       0.41  104.7263   38.2606
   1      14.00  104.7263   38.2606
   1       2.00  104.7263   38.2606
   1       8.00  104.7263   38.2606
   1     322.00  104.7263   38.2606
1402ST CHRLS      2        0.         2.  104.5250   38.2118 0.21-0.12    0
                  2    2       0.50  104.5250   38.2118
   1       1.20  104.6025   38.2534
   1       2.60  104.6025   38.2534
1404HAMP-BEL      1       40.         2.  104.6954   38.2548 0.05 0.13    7
                  3    1       0.50  104.6954   38.2548
   1       1.03  104.7184   38.2705
   1       0.29  104.7184   38.2705
   1       1.60  104.7184   38.2705
1407W PUEBLO      1      500.        1.7  104.6519   38.2759  .05 0.04    7
                  5    1       0.50  104.6519   38.2759    1002.
   1       1.20  104.7116   38.2716
   1       1.00  104.7116   38.2716
   1       0.60  104.7116   38.2716
   1      15.00  104.7116   38.2716
   2      16.    104.6519   38.2759  467.
1410PUEBL WW      2     4700.         1.  104.6544   38.2740 0.27 0.03    7
                  4    2       0.50  104.6544   38.2740
   1       2.50  104.6701   38.2706
   1       1.20  104.6701   38.2706
   1       4.60  104.6701   38.2706
   1      45.00  104.6701   38.2706
1416RVRSD DY      1       55.         2.  104.6407   38.2660-0.10-0.09    7
                  1    1       0.50  104.6407   38.2660
   1       1.00  104.6552   38.2686
1419BTH-ORCH      1     1451.        3.4  104.5000   38.2691 -.05  .05    7
                  6    1       0.50  104.5000   38.2691     1260.
   1       7.00  104.5857   38.2538
   1       8.00  104.5857   38.2538
   1       1.00  104.5857   38.2538
   1       2.00  104.5857   38.2538
   1       0.00  104.5857   38.2538
   2       5.    104.5        38.2691 1548.
```

Attachment E--*Basin water-user file for model calibration, 1943-74*--Continued

```
1422EXCLSIOR       1      1583.       3.3  104.3916   38.2683-0.02 0.11    7
                   3    1      0.80  104.3916   38.2683      2726.
   1     20.00  104.4988   38.2601
   1     40.00  104.4988   38.2601
   2     52.    104.3916   38.2683 3173.
1425COLLIER        1      1000.       0.8  104.2895   38.2338  .20 -.12    3
                   3    1      0.80  104.2895   38.2338      1086.
   1      4.00  104.3458   38.2426
   1     22.00  104.3458   38.2426
   2     3.     104.2895   38.2338 1253.
1428COLORADO       1     50800.      -0.9  104.10     38.24    .05  .07    3
                   5    1      0.70  104.1283   38.2128      4800.
   1    756.28  104.3106   38.2453
   2    40.     104.1283   38.2128 1800.
   3  15000.00  104.3106   38.2453           854
  -3      600.  103.658    38.172           1107
  -3     2000.  103.684    38.224           1106
   2       45.  104.1283   38.2128           1800
1431HIGHLINE       1     24100.      -1.0  104.05     37.9855 0.27-0.05    3
                   9    4      0.25  103.99     38.08        4500.
   1     40.00  104.2392   38.2269
   1      0.60  104.2392   38.2269
   1     16.00  104.2392   38.2269
   1     32.50  104.2392   38.2269
   1     30.00  104.2392   38.2269
   1      2.00  104.2392   38.2269
   1    380.50  104.2392   38.2269
   3     3200.  104.2392   38.2269           824
   2   100.     103.7651   37.9855 4700.
1434OXFD-FRM       1      6000.      -1.2  103.9857   38.1127 0.27-0.06    3
                   3    1      0.60  103.9857   38.1127      1800.
   1     13.40  104.1573   38.1819
   1    116.00  104.1573   38.1819
   2    50.     103.9857   38.1127 3179.
1701OTERO          1     10000.       0.5  103.5119   37.9684 0.01-0.08    8
                   4    1      0.80  103.5119   37.9684      1608.
   1    123.00  104.00     38.1416
   1    334.92  104.00     38.1416
   3    850.    104.00     38.1416           869
   2    34.     103.5119   37.9684 1234.
1703BLDWN-ST       1       650.       2.   103.9140   38.1575-0.03 -.05    8
                   1    1      0.80  103.9140   38.1575
   1     22.00  103.9738   38.1387
1704CATLIN         1     18800.      -1.2  103.6294   37.9623 0.16-0.14    8
                   4    1      0.30  103.6294   37.9623      4800.
   1     22.00  103.9460   38.1273
   1    226.00  103.9460   38.1273
   1     97.00  103.9460   38.1273
   2     63.    103.6294   37.9623 5300.
```

Attachment E--*Basin water-user file for model calibration, 1943-74*--Continued

```
1707HOLBROOK       1    19550.       -1.4  103.3980   38.0939-0.05 -.02    8
                   5    1      0.50  103.3980   38.0939     1122.
   1    155.00  103.8444   38.1212
   1    445.00  103.8444   38.1212
  -3   20000.   103.661    38.045            1202
  -3   20000.   103.580    38.029            1203
   2    50.     103.3980   38.0939 1032.
1710RCKY FRD       1     8200.       -1.5  103.6746   38.0033 0.21-0.13    8
                   3    1      0.30  103.6746   38.0033     1900.
   1    111.76  103.8264   38.1124
   1     96.54  103.8264   38.1124
   2     60.    103.6746   38.0033 2200.
1716FT LYON        1    91300.       -1.1  102.6500   38.2450-0.06 0.06    6
                   6    5      0.30  102.6500   38.2450     4500.
   1    164.64  103.5878   38.0110
   1    597.16  103.5878   38.0110
   1    171.20  103.5878   38.0110
  -3    20000.  103.372    38.144            1236
  -3    20000.  103.231    38.236            1238
   2    350.    102.6500   38.2450 4500.
1719LAS ANMS       1     4650.       -1.7  103.2336   38.0288 0.01-0.10    6
                   6    1      0.40  103.20     38.04       4800.
   1     22.00  103.3546   38.0566
   1      5.50  103.3546   38.0566
   1     22.00  103.3546   38.0566
   1     80.00  103.3546   38.0566
   1     44.80  103.3546   38.0566
   2     60.    103.20     38.04   5200.
6701KEESEE         1     1900.        0.9  102.7470   38.0864 0.22-0.09    6
                   5    1      0.50  102.6      38.0864      840.
   3      -.01  102.8396   38.0761           1300
   1      9.00  102.8396   38.0761
   1      4.50  102.8396   38.0761
   1     15.00  102.8396   38.0761
   2     15.    102.7470   38.0864 1342.
6704FT BENT        1     6840.        1.1  102.71     38.0550 0.15-0.12    6
                   7    1      0.50  102.60     38.0550     2776.
   3      -.08  102.8394   38.0761           1300
   1     27.77  102.8394   38.0761
   1     32.77  102.8394   38.0761
   1     26.77  102.8394   38.0761
   1     50.00  102.8394   38.0761
   1     80.00  102.8394   38.0761
   2     41.    102.5591   38.0550 2250.
6707AMITY          1    37800.        1.2  102.0445   38.1303  .15 0.08    5
                   5    1      0.35  102.0445   38.1303     5500.
   3      -.29  102.7588   38.0908           1300
   1    283.50  102.7588   38.0908
   1    500.00  102.7588   38.0908
  -3    20000.  102.707    38.308            1221
   2    200.    102.0445   38.1303 7498.
```

```
6710LAMAR          1     8700.      -1.5  102.3545   38.0427 0.15-0.18    5
                   7    1      0.50  102.3545   38.0427     1937.
   3      -.11  102.6430   38.1049           1300
   1     15.75  102.6430   38.1049
   1     72.09  102.6430   38.1049
   1     13.64  102.6430   38.1049
   1     11.70  102.6430   38.1049
   1    184.27  102.6430   38.1049
   2    27.     102.3545   38.0427 1728.
6713HYDE           1      970.       1.0  102.5600   38.1138 0.07 0.04    5
                   3    1      0.50  102.5600   38.1138     1620.
   3      -.01  102.6115   38.1055           1300
   1     23.44  102.6115   38.1055
   2     50.    102.5600   38.1138 1039.
6716MANVEL         1      750.       2.1  102.3431   38.0573 0.15-0.12    4
                   3    1      0.50  102.3431   38.0573     3125.
   3      -.02  102.4942   38.0948           1300
   1     54.00  102.4942   38.0948
   2     145.   102.3431   38.0573 2412.
6719X-Y GRHM       1     6000.       0.5  102.2436   38.0397 0.0 -0.15    4
                   4    1      0.50  102.2436   38.0397     2782.
   3      -.05  102.4252   38.1005           1300
   1     69.00  102.4252   38.1005
   1     61.00  102.4252   38.1005
   2     80.    102.2436   38.0397 3054.
6722BUFFALO        1     5000.       1.1  102.1372   38.0646 0.25 0.05    4
                   3    1      0.50  102.1372   38.0646     1759.
                                         112
   3      -.02  102.3284   38.1005           1300
   1     67.50  102.3284   38.1005
   2     25.    102.1372   38.0646  864.
6725SSN-STUB       1      300.        2.  102.1670   38.0302-0.10-0.08    4
                   5    1      0.80  102.1670   38.0302      442.
   3      -.01  102.2181   38.0468           1300
   1      7.54  102.2181   38.0468
   1     18.00  102.2181   38.0468
   1      7.20  102.2181   38.0468
   2       57.  102.1670   38.0302  860.
  99KANSAS         1   30000.         3.     102.01      38.05-0.10 0.05    4
                   1    3       0.00
   3      -.50  102.01     38.05             1300
 824TURQUOIS       5    17371.        1.  106.3739   39.2528  .30  .05
                   2    3
   5    1000.   106.3739   39.2528
   4  17500.    106.80     39.20
 854TWIN LKS       5    55000.        1.  106.3125   39.0807  .45 -.10
                   3    3
   5    1000.   106.3125   39.0807
   5    1000.   106.3125   39.0807
   4  55000.    106.90     39.15
```

```
 869CLR CK R      5    11440.         1.  106.2444   38.99     .45 -.10
                  5    3
   5     45.    106.27      38.99
   5     25.    106.27      38.99
   4   9402.    106.6       39.25
   4   9402.    106.61      39.26
   4   9402.    106.59      39.24
1106LK HENRY      5    10300.         1.  103.684    38.224    .20  .06     0
                  2    3
   5     20.    104.3106   38.2453
   5     10.    104.3106   38.2453
1107MEREDITH      5    26028.         1.  103.658    38.172   -.06  .04     0
                  1    3
   5    250.    104.3106   38.2453
1202DYE RES       5     7986.         1.  103.661    38.045    .26 -.30
                  2    3
   5    100.    103.8444   38.1212
   5    100.    103.8444   38.1212
1203HLBROK R      5     7472.         1.  103.580    38.029   -.02 -.25
                  2    3
   5    100.    103.8444   38.1212
1221GR PLAIN      5   125000.         1.  102.707    38.308    .20  .04
   5    100.    103.8444   38.1212
                  1    3
   5    400.    103.5878   38.0110
1236HRS CK R      5    28000.         1.  103.372    38.144    0.0  .20
                  2    3
   5    250.    103.8444   38.1212
   5    125.    103.8444   38.1212
1238ADB CK R      5    85000.         1.  103.231    38.236   -.06  .07
                  2    3
   5    500.    103.8444   38.1212
   5    250.    103.8444   38.1212
1300JM RES        5   701775.         1.  102.92     38.07     .17  .05
                  1    3
   5  20000.00  102.9369   38.0681
```

Attachment F--*Basin-description file for model calibration, 1975-85*

```
CALIBRATION DATA USING STREAMFLOW, SNOWPACK, AND PRECIPITATION TO ESTIMATE FLOW
   42
1000.     250.      1000.     2500.
90615COLUMBIN     39.2500  106.6000 -999      -.50      .32       0.        0.        .65
             110       0.0         .019      200.      -.05
             110       0.0         .012      200.      -.05
             110       0.0         .009      200.      -.05
             123       0.0         2.15      200.      -.05
             113       1.7         .277      800.      -.20
             113       0.65        1.05      800.      -.20
             113       0.08        1.32      800.      -.20
             113       0.12        .683      800.      -.20
             113       0.0         .452      800.      -.20
             110       0.0         .050      200.      -.05
             110       0.0         .044      200.      -.05
             110       0.0         .011      200.      -.05
90620EWING        39.2600  106.6100 -999      -.55      .44       0.        0.        .65
             110       0.25        .019      200.      -.05
             110       0.22        .012      200.      -.05
             110       0.26        .009      200.      -.05
             123      .0001        2.15      200.      -.05
             113       1.9         .277      800.      -.20
             113       0.41        1.05      800.      -.20
             113       0.07        1.32      800.      -.20
             113       0.18        .683      800.      -.20
             113       0.20        .452      800.      -.20
             110       0.54        .050      200.      -.05
             110       0.33        .044      200.      -.05
             110       0.26        .011      200.      -.05
90625WURTZ        39.2400  106.5900 -999      -.45      .20       0.        0.        .65
             110       0.0         .019      200.      -.05
             110       0.0         .012      200.      -.05
             110       0.0         .009      200.      -.05
             123       0.0         2.15      200.      -.05
             113       5.4         .277      800.      -.20
             113       1.0         1.05      800.      -.20
             113       0.11        1.32      800.      -.20
             113       0.24        .683      800.      -.20
             113       0.03        .452      800.      -.20
             110       0.0         .050      200.      -.05
             110       0.0         .044      200.      -.05
             110       0.0         .011      200.      -.05
```

90775BUSK-IVH		39.2000	106.8000	-999	-.70	.10	0.	0.	.65
	110	0.0	.019	200.	-.05				
	110	0.0	.012	200.	-.05				
	110	0.03	.009	200.	-.05				
	123	.0006	2.15	200.	-.05				
	113	6.6	.277	400.	-.20				
	113	2.1	1.05	400.	-.20				
	113	0.36	1.32	400.	-.20				
	113	0.66	.683	400.	-.20				
	113	0.43	.452	400.	-.20				
	110	1.8	.050	200.	-.05				
	110	0.42	.044	200.	-.05				
	110	0.0	.011	200.	-.05				
90730TW LK TN		39.1500	106.9000	-999	-.70	.05	0.	0.	.65
	110	2.9	.019	200.	-.05				
	110	2.5	.012	200.	-.05				
	110	2.3	.009	200.	-.05				
	123	.0020	2.15	200.	-.05				
	113	58.	.277	400.	-.20				
	113	15.	1.05	400.	-.20				
	113	3.1	1.32	400.	-.20				
	113	5.5	.683	400.	-.20				
	113	4.3	.452	400.	-.20				
	110	9.5	.050	200.	-.05				
	110	9.5	.044	200.	-.05				
	110	3.5	.011	200.	-.05				
91150LARKSPUR		39.1000	107.0000	-999	-.70	0.0	0.	0.	.65
	110	0.0	.019	200.	-.05				
	110	0.0	.012	200.	-.05				
	110	0.0	.009	200.	-.05				
	123	0.0	2.15	200.	-.05				
	113	0.24	.277	800.	-.20				
	113	0.080	1.05	800.	-.20				
	113	0.013	1.32	800.	-.20				
	113	0.053	.683	800.	-.20				
	113	0.10	.452	800.	-.20				
	110	0.0	.050	200.	-.05				
	110	0.0	.044	200.	-.05				
	110	0.0	.011	200.	-.05				
90772BOUSTEAD		39.1000	106.8000	-999	-.40	-.30	0.	0.	.65
	110	5.8	.019	200.	-.05				
	110	5.0	.012	200.	-.05				
	110	4.6	.009	200.	-.05				
	123	.0040	2.15	200.	-.05				
	113	116.	.277	200.	-.20				
	113	30.	1.05	200.	-.20				
	113	6.2	1.32	200.	-.20				
	113	11.	.683	200.	-.20				
	113	8.6	.452	200.	-.20				
	110	19.	.050	200.	-.05				
	110	19.	.044	200.	-.05				
	110	7.0	.011	200.	-.05				

Attachment F--*Basin-description file for model calibration, 1975-85*--Continued

812ARK LEAD	39.26	106.34	860	.10	-.05	0.	-6.8	.64
110	13.8	.019	740.	-.35				
110	13.8	.012	740.	-.35				
110	14.6	.009	740.	-.35				
123	.00967	2.15	740.	-.35				
113	76.7	.277	740.	-.35				
113	16.6	1.05	740.	-.35				
113	3.13	1.32	740.	-.35				
113	7.18	.683	740.	-.35				
113	8.27	.452	740.	-.35				
110	25.7	.050	740.	-.35				
110	19.7	.044	740.	-.35				
110	14.9	.011	740.	-.35				
820LAKE FK	39.26	106.45	825	-.13	.18	0.	0.	.65
110	2.35	.019	100.	-.05				
110	2.07	.012	100.	-.05				
110	1.95	.009	100.	-.05				
123	.00109	2.15	100.	-.05				
113	12.3	.277	250.	-.20				
113	5.79	1.05	250.	-.20				
113	1.74	1.32	250.	-.20				
113	3.03	.683	250.	-.20				
113	2.85	.452	250.	-.20				
110	6.23	.050	100.	-.05				
110	4.07	.044	100.	-.05				
110	3.10	.011	100.	-.05				
825LAKE FK	39.2528	106.3739	860	.15	.16	0.	0.	.65
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
830HALFMOON	39.15	106.38	860	-.42	-.10	0.	7.9	.50
110	4.01	.019	98.	-.04				
110	3.66	.012	98.	-.04				
110	3.52	.009	98.	-.04				
123	.00211	2.15	98.	-.04				
113	19.9	.277	150.	-.22				
113	5.99	1.05	150.	-.22				
113	1.77	1.32	150.	-.22				
113	4.68	.683	150.	-.22				
113	4.63	.452	150.	-.22				
110	10.9	.050	98.	-.04				
110	7.48	.044	98.	-.04				
110	5.12	.011	98.	-.04				

```
845LAKE CK       39.05    106.37    855       -.50        -.10          0.        -6.8        .64
           110      11.3       .019       88.       -.16
           110      10.2       .012       88.       -.16
           110      10.0       .009       88.       -.16
           123      .0071      2.15       88.       -.16
           113      100.       .277      100.       -.13
           113      29.5       1.05      100.       -.13
           113      6.36       1.32      100.       -.13
           113      12.6       .683      100.       -.13
           113      12.7       .452      100.       -.13
           110      31.4       .050       88.       -.16
           110      19.9       .044       88.       -.16
           110      14.0       .011       88.       -.16
855LAKE CK       39.0807  106.3125  860        .15         .18          0.          0.        00.0
             1
             1
             1
             1
             1
             1
             1
             1
             1
             1
             1
             1
860ARK GRNT      39.04    106.24    915        .13          0.          0.          .2        .63
           110      66.0       .019      426.       -.22
           110      67.5       .012      426.       -.22
           110      74.9       .009      426.       -.22
           123      .079       2.15      426.       -.22
           113      87.4       .277      426.       -.22
           113      6.70       1.05      426.       -.22
           113      4.50       1.32      426.       -.22
           113      31.9       .683      426.       -.22
           113      31.0       .452      426.       -.22
           110      96.1       .050      426.       -.22
           110      84.3       .044      426.       -.22
           110      64.1       .011      426.       -.22
865CLEAR CK      38.99    106.28    870       -.30        -.27          0.         7.9        .50
           110      13.2       .019       87.       -.16
           110      12.4       .012       87.       -.16
           110      12.2       .009       87.       -.16
           123    .00661       2.15       87.       -.16
           113      54.9       .277      250.       -.13
           113      15.7       1.05      250.       -.13
           113      4.16       1.32      250.       -.13
           113      10.6       .683      250.       -.13
           113      12.1       .452      250.       -.13
           110      32.9       .050       87.       -.16
           110      21.9       .044       87.       -.16
           110      16.1       .011       87.       -.16
```

870CLEAR CK	38.99	106.2444	915	.10	-.20	0.	0.	00.0
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
1								
890COTTNWD	38.78	106.23	915	-.30	-.30	0.	7.9	.50
110	22.8	.019	240.	-.20				
110	20.6	.012	240.	-.20				
110	19.1	.009	240.	-.20				
123	.00732	2.15	240.	-.20				
113	31.6	.277	240.	-.20				
113	8.60	1.05	240.	-.20				
113	2.39	1.32	240.	-.20				
113	8.32	.683	240.	-.20				
113	11.6	.452	240.	-.20				
110	36.5	.050	240.	-.20				
110	30.5	.044	240.	-.20				
110	25.4	.011	240.	-.20				
915ARK SLID	38.51	105.98	937	0.	.18	0.	-6.8	.64
110	127.	.019	2900.	-.43				
110	118.	.012	2900.	-.43				
110	96.1	.009	2900.	-.43				
123	.026	2.15	2900.	-.43				
113	58.4	.277	2900.	-.43				
113	9.25	1.05	2900.	-.43				
112	.00027	5.00	2900.	-.43				
113	24.9	.683	2900.	-.43				
113	27.2	.452	2900.	-.43				
110	118.	.050	2900.	-.43				
110	154.	.044	2900.	-.43				
110	135.	.011	2900.	-.43				
937ARK WELL	38.48	105.94	945	.15	0.	0.	-6.8	.64
110	57.6	.019	2900.	-.43				
110	54.5	.012	2900.	-.43				
110	43.3	.009	2900.	-.43				
123	.0055	2.15	2900.	-.43				
113	33.0	.277	2900.	-.43				
113	0.17	1.05	2900.	-.43				
113	.378	1.32	2900.	-.43				
113	5.28	.683	2900.	-.43				
113	14.6	.452	2900.	-.43				
110	47.2	.050	2900.	-.43				
110	87.6	.044	2900.	-.43				
110	71.1	.011	2900.	-.43				

945ARK PARK	38.46	105.38	960	-.40	.15	0.	-6.8	.64	
2	0.00	128.	1600.	-.30					
2	0.00	119.	1600.	-.30					
2	0.00	65.5	1600.	-.30					
2	0.00	44.4	1600.	-.30					
2	7.0	21.1	1600.	-.30					
114	10.0	1.9	1600.	-.30					
2	220.	10.0	1600.	-.30					
2	0.00	47.2	1600.	-.30					
2	0.00	7.33	1600.	-.30					
2	0.00	30.0	1600.	-.30					
2	0.00	48.6	1600.	-.30					
2	0.00	103.	1600.	-.30					
950GRAPE CK	38.16	105.48	960	-.20	.15	0.	-6.8	.64	
15	0.	1.	1100.	-.30					
15	0.	1.	1100.	-.30					
15	0.	1.	1100.	-.30					
15	0.	1.	1100.	-.30					
15	0.	1.	1200.	-.32					
15	0.	1.	1200.	-.32					
15	0.	1.	1200.	-.32					
15	0.	1.	1200.	-.32					
15	0.	1.	1200.	-.32					
15	0.	1.	1100.	-.30					
15	0.	1.	1100.	-.30					
15	0.	1.	1100.	-.30					
960ARK CANC	38.41	105.25	970	-.20	-.30	0.	-6.2	.64	
2	-43.	8.	1100.	-.24					
2	-42.	18.	1100.	-.24					
2	-48.	11.	1100.	-.24					
2	-90.	23.6	1100.	-.24					
2	-70.0	3.48	1300.	-.26					
2	-200.	143.	1300.	-.26					
2	-100.	11.5	1300.	-.26					
102	.056	5.78	1300.	-.26					
2	-70.	24.	1300.	-.26					
2	-73.	13.9	1100.	-.24					
2	-79.	11.	1100.	-.24					
2	-47.	18.	1100.	-.24					
970ARK PORT	38.37	105.02	992	-.25	-.30	-1.	8.4	.61	
2	-43.	8.	4400.	-.37					
2	-42.	18.	4400.	-.37					
2	-48.	11.	4400.	-.37					
2	-62.	5.	4400.	-.37					
2	-36.	13.	4400.	-.37					
2	-200.	90.0	4400.	-.37					
2	-43.	8.	4400.	-.37					
2	-21.	12.	4400.	-.37					
2	-70.	24.	4400.	-.37					
2	-73.	13.	4400.	-.37					
2	-79.	11.	4400.	-.37					
2	-47.	18.	4400.	-.37					

991BEAVER C		38.36	104.95	992	0.0	.15	0.	-248.2	.97
	16	0.	1.	3000.	-.30				
	16	0.	1.	3000.	-.30				
	16	0.	1.	3000.	-.30				
	16	0.	1.	3000.	-.30				
	16	0.	1.	2000.	-.30				
	16	0.	1.	2000.	-.30				
	16	0.	1.	2000.	-.30				
	16	0.	1.	2000.	-.30				
	16	0.	1.	2000.	-.30				
	16	0.	1.	3000.	-.30				
	16	0.	1.	3000.	-.30				
	16	0.	1.	3000.	-.30				
992ARK A PB		38.29	104.80	994	0.0	.20	-1.	-38.4	.75
	7	17.0	288.	3000.	-.32				
	7	24.0	210.	3000.	-.32				
	7	-20.0	125.	3000.	-.32				
	7	-47.0	200.	3000.	-.32				
	7	159.	0.	3000.	-.32				
	7	-100.	250.	3000.	-.32				
	7	-82.0	75.5	3000.	-.32				
	7	-36.0	91.0	3000.	-.32				
	7	50.	50.0	3000.	-.32				
	7	-5.	130.	3000.	-.32				
	7	38.0	220.	3000.	-.32				
	7	42.0	220.	3000.	-.32				
994ARK PUBL		38.25	104.65	1095	-.30	-.30	0.	-38.4	.75
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
1065FOUNT PB		38.26	104.61	1095	0.	.15	0.	-508.8	1.04
	17	0.	1.	5000.	-.17				
	17	0.	1.	5000.	-.17				
	17	0.	1.	5000.	-.17				
	17	0.	1.	5000.	-.17				
	17	0.	1.	4000.	-.17				
	17	0.	1.	4000.	-.17				
	17	0.	1.	4000.	-.17				
	17	0.	1.	4000.	-.17				
	17	0.	1.	4000.	-.17				
	17	0.	1.	5000.	-.17				
	17	0.	1.	5000.	-.17				
	17	0.	1.	5000.	-.17				

```
1090ST CHARL     38.20    104.51   1095       -.20       -.25        0.    -248.2       .97
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
            18      0.        1.      5000.      -.29
1095ARK AVON     38.23    104.40   1170        .10        .15       -1.     -18.7       .69
             3     -2.        0.      4700.      -.27
             3      0.       15.      4700.      -.27
             3      0.       25.      4700.      -.27
             3     -5.0      25.      4700.      -.27
             3    -80.0      20.      4700.      -.31
             3    -200.      50.      4700.      -.31
             3     100.      20.      4700.      -.31
             3     70.0      13.2     4700.      -.31
             3    -14.2      45.      4700.      -.31
             3     -1.7      40.      4700.      -.27
             3      0.       30.      4700.      -.27
             3      0.        7.      4700.      -.27
1160HUERF R      37.97    104.48   1170        .10       -.15        0.    -458.8      1.16
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
            19      0.        1.      3900.      -.23
1170ARK NPST     38.19    104.20   1197        .15        .10       -1.     -71.0       .80
             3     23.        0.      2500.      -.17
             3     15.       60.      2500.      -.17
             3    -31.      100.      2500.      -.17
             3    -94.0      75.      2500.      -.17
             3    -32.0      40.      2500.      -.22
             3    -30.0     140.      2500.      -.22
             3    -150.      50.      2500.      -.22
             3    -80.       13.8     2500.      -.22
             3    -60.0     120.      2500.      -.22
             3    -55.0     150.      2500.      -.17
             3    -47.      110.      2500.      -.17
             3      0.       30.      2500.      -.17
```

1195APISH R	38.07	103.99	1197	-.50	-.25	0.	-438.2	1.14
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
20	0.	1.	3200.	-.27				
1197ARK CAT	38.12	103.91	1230	.10	.10	0.	-35.9	.74
3	-30.	0.	1200.	-.02				
3	-16.	0.	1200.	-.02				
3	31.	0.	1200.	-.02				
3	25.0	4.8	1200.	-.02				
103	2.0	1.6	2800.	-.23				
3	-100.	16.2	2800.	-.23				
3	120.	14.2	2800.	-.23				
3	200.	13.8	2800.	-.23				
3	30.0	18.6	2800.	-.23				
3	50.0	3.3	1200.	-.02				
3	65.	0.	1200.	-.02				
3	-30.0	0.	1200.	-.02				
1230ARK LAJU	37.98	103.53	1240	-.25	.20	-1.	-189.3	.94
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
8	-7.3	6.1	8300.	-.29				
108	18.	3.2	8300.	-.31				
108	250.	1.3	8300.	-.31				
8	-34.6	18.1	8300.	-.31				
8	31.6	20.0	8300.	-.31				
8	-20.6	22.4	8300.	-.31				
8	-2.4	3.8	8300.	-.29				
8	0.	0.	8300.	-.29				
8	0.	0.	8300.	-.29				
1240ARK ANMS	38.08	103.23	1289	-.40	.15	-1.	-231.8	.94
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				
6	-7.3	6.4	7100.	-.24				
6	-150.	11.9	7100.	-.30				
6	-350.	20.3	7100.	-.30				
6	-80.0	16.2	7100.	-.30				
6	-31.6	20.3	7100.	-.30				
6	-20.6	22.6	7100.	-.30				
6	-2.4	3.4	7100.	-.24				
6	0.	0.	7100.	-.24				
6	0.	0.	7100.	-.24				

```
1285PURG ANS     38.03     103.21    1289        -.10        -.25          0.     -385.0       1.06
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.21
             21        0.         1.      6000.      -.21
             21        0.         1.      6000.      -.21
             21        0.         1.      6000.      -.21
             21        0.         1.      6000.      -.21
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.12
             21        0.         1.      6000.      -.12
1289ARK A JM     38.07     103.15    1305        -.05         .15          0.     -243.8        .97
              5        0.         0.      4100.      -.09
              5        0.         0.      4100.      -.09
              5        0.         0.      4100.      -.09
              5      -2.8        2.2      4100.      -.09
              5      -9.3        3.8      5900.      -.21
              5     -12.1        5.4      5900.      -.21
              5     -13.3        5.9      5900.      -.21
              5     -12.1        6.1      5900.      -.21
              5      -7.9        7.1      5900.      -.21
              5      -0.9        1.0      4100.      -.09
              5        0.         0.      4100.      -.09
              5        0.         0.      4100.      -.09
1305ARK JM R     38.07     102.92    1330         .00        -.20          0.     -243.8        .97
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
              1
1330ARK LAMR     38.12     102.63    1355        -.35         .15          0.     -222.3        .98
              5        0.         0.      8800.      -.16
              5        0.         0.      8800.      -.16
              5        0.         0.      8800.      -.16
              5      -50.        6.6      8800.      -.16
              5     -200.       11.3      6300.      -.24
            104      1.00        2.5      6300.      -.24
              5     -130.       17.7      6300.      -.24
              5     -25.0       18.5      6300.      -.24
              5     -23.9       21.3      6300.      -.24
              5      -2.8        3.2      8800.      -.16
              5        0.         0.      8800.      -.16
              5        0.         0.      8800.      -.16
```

1341BIG SAND		38.13	102.49	1355	.08	.08	0.	-6.8	1.16
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.15				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
	22	0.	1.	5100.	-.05				
1355ARK HOLY		38.0436	102.1192	1375	-.30	-.25	0.	0.	00.0
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
	1								
1375ARK COOL		38.05	102.02	-999	-.05	.15	0.	-6.5	.92
	4	0.	0.	13000.	-.27				
	4	0.	0.	13000.	-.27				
	4	0.	0.	13000.	-.27				
	4	70.0	7.0	13000.	-.27				
	104	23.0	2.10	10000.	-.29				
	104	30.0	1.85	10000.	-.29				
	4	30.0	20.0	10000.	-.29				
	4	80.0	18.5	10000.	-.29				
	4	35.0	19.4	10000.	-.29				
	4	-2.9	2.7	13000.	-.27				
	4	0.	0.	13000.	-.27				
	4	0.	0.	13000.	-.27				

Attachment G--*Additional basin-description file for model calibration, 1975-85*

```
MAIN STEM RESERVOIRS PLUS OTHER INITIAL DATA
PET     0.    0.    0.    0.12  0.40  0.52  0.57  0.52  0.34  0.04  0.    0.
EVAP    0.    0.    0.    0.75  0.95  1.00  1.10  0.85  0.60  0.50  0.10  0.
AGDMND  0.09  0.11  0.18  0.27  0.40  0.52  0.57  0.52  0.34  0.27  0.22  0.14
SESNAL  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00
AQUIFER .2    10000.
DRINK    .13
CONV FAC69.04853.310  1.38  1.55  1.25 104.0 104.7 .80  60.3   1.
   12
  824TURQUOIS    120490.   40000.     1665.  106.3739   39.2528   45000.     100.  .10  .05
  854TWIN LKS    67833.     5000.     1370.  106.3125   39.0807   15000.      75. -.05  .05
  869CLR CK R     11440.    1500.      382.  106.2444   38.99      2000.     100. -.05  0.0
 1106LK HENRY     10300.              1120.  103.684    38.224                      .20  .05
 1107MEREDITH     28000.              3220.  103.658    38.172                     -.05  .03
 1202DYE RES       4000.               800.  103.661    38.045                      .26 -.07
 1203HLBROK R      7000.               673.  103.580    38.029                     -.02  .02
 1221GR PLAIN    130000.             12653.  102.707    38.308                      .10  .05
 1236HRS CK R     28000.              2603.  103.372    38.144                     -.05 -.03
 1238ADB CK R     65000.              5147.  103.231    38.236                     -.05  .05
 1300JM RES      400000.             17500.  102.92     38.07     10000.    1000. -.08 -.05
  993PUEBLO R    264000.   30000.     5350.  104.65     38.25     10000.     125.  .25 -.10
```

Attachment G--*Additional basin-description file for model calibration, 1975-85*--Continued

```
GW01
GW02
GW03
GW04
GW05
GW06
GW06a
GW07       5000. 200.
GW08
GW08a
GW09
GW10
GW11
GW12      10000. 100. 25000. 100.
GW13
GW14
GW15
GW16      20000. 100. 25000. 100.
GW17
GW18      20000. 125. 10000. 125.
GW19
GW20
GW21                  60000. 200.
GW22
GW23      10000. 300. 10000. 400.
GW23a
GW24
GW25
GW26      40000. 350. 15000. 500.
GW27
GW28      30000. 700. 80000. 700.
GW29
GW30      40000. 800. 7000001500.
GW31      100000 900.
GW32      50000.1000. 3000001500.
GW33
GW34      30000.1500. 1000001500.
GW35
GW36      60000.2000. 2000001500.
GW37
GW38      2000003000. 3000004000.
GW39      4000003500. 3000004000.
```

Attachment H--*Basin water-user file for model calibration, 1975-85*

```
BASIN USERS IN 1980
  83
 1101MARTIN        1      240.        2.  106.3474   39.2422 0.16 0.08    10
                   1    1      0.20  106.3474   39.2422      800.
   1      3.43  106.338    39.2563
 1104BERRY         1      200.        2.  106.3604   39.2407 0.35-0.01    10
                   1    1      0.20  106.345    39.2407      800.
   1      4.00  106.335    39.2539
 1108WELL-STR      1       99.        2.  106.3566   39.2571-0.05-0.03    10
                   1    1      0.20  106.343    39.240       800.
   1      8.00  106.332    39.252
 1110BEAVER D      1      320.        2.  106.3497   39.2420 0.30-0.07    10
                   2    1      0.20  106.341    39.239       800.
   1      5.71  106.329    39.2505
   1      1.43  106.329    39.2505
 1116YOUNGR 2      1      340.        2.  106.3601   39.2261-0.05 0.06    10
                   1    1      0.20  106.340    39.2261      800.
   1      6.29  106.326    39.2384
 1122DERRY 1       1      400.        2.  106.3285   39.1446 0.30-0.04    10
                   1    1      0.20  106.3285   39.1446      800.
   1      4.00  106.3258   39.1841
 1125UPPR RIV      1      600.        2.  106.3289   39.1822-0.05-0.02    10
                   1    1      0.20  106.3289   39.1822      800.
   1     14.00  106.3404   39.2008
 1128PIONEER       1      320.        2.  106.3202   39.1365-0.15-0.10    10
                   1    1      0.20  106.3202   39.1365      800.
   1      7.00  106.3156   39.1439
 1130WHEEL         1      200.        2.  106.3152   39.1338 0.25-0.14    10
                   1    1      0.20  106.3152   39.1338      800.
   1     16.00  106.3124   39.1379
 1131CHAMP         1      320.        2.  106.3208   39.1429-0.08-0.05    10
                   1    1      0.20  106.3208   39.1429      800.
   1      5.00  106.3157   39.1500
 1137LANGHOFF      1       80.        2.  106.2051   38.9731-0.05 0.0     10
                   1    1      0.20  106.2051   38.9731      800.
   1      4.80  106.2130   38.9869
 1140DRYFIELD      1       40.        2.  106.2036   38.9614 0.25-0.05    10
                   1    1      0.20  106.2036   38.9614      800.
   1      6.20  106.2049   38.9678
 1143RVRSD-AL      1      300.       5.0  106.1804   38.9098-0.05-0.05    10
                   3    1      0.20  106.1804   38.9098      800.
   1      1.00  106.1896   38.9463
   1      9.00  106.1896   38.9463
   1     16.00  106.1896   38.9463
 1146HELENA        1      320.       6.0  106.1228   38.8094 0.28 0.03     1
                   3    1      0.20  106.1228   38.8094      800.
   1      1.00  106.1142   38.8331
   1     19.00  106.1142   38.8331
   1     16.00  106.1142   38.8331
 1147BV SMELT      4        0.        2.  106.4435   38.6588-0.05 0.05     0
                   1    2      1.00  106.4435   38.6588
   1    115.00  106.1216   38.8474
```

```
1149BRY-ALEN      1      100.        2.  106.0750   38.7681-0.02 0.02     1
                  2   1      0.20  106.0750   38.7681       800.
   1      5.00  106.1033   38.8131
   1      6.00  106.1033   38.8131
1155SALIDA        1      900.        2.  106.0000   38.5597 0.23-0.09     9
                  1   1      0.20  106.0000   38.5597       800.
   1     20.00  106.0569   38.6153
1158KRAFT         1      240.        2.  106.0794   38.6000-0.03 0.04     9
                  1   1      0.20  106.0794   38.6000       800.
   1      5.00  106.0558   38.6197
1161SUNNY PK      1      700.        2.5 106.0393   38.5761 0.30 0.04     9
                  2   1      0.20  106.0393   38.5761       800.
   1     14.17  106.0670   38.6043
   1     25.00  106.0670   38.6043
1164BILL-HAM      1      534.        3.6 106.0038   38.5524-0.05 0.03     9
                  2   1      0.20  106.0038   38.5524       800.
   1     16.00  106.0787   38.5794
   1      1.00  106.0787   38.5794
1201PICKETT       1       90.        2.  105.8934   38.4826-0.03 0.02     2
                  1   1      0.20  105.8934   38.4826       800.
   1      3.80  105.9150   38.4968
1204PLEASANT      1      250.        3.9 105.8132   38.4381-0.05-0.01     2
                  2   1      0.20  105.8132   38.4381       800.
   1      2.00  105.8413   38.4592
   1      8.00  105.8413   38.4592
1210S CANON       1     1280.        4.8 105.2009   38.4306-0.05 0.12     2
                  8   1      0.20  105.2009   38.4306       800.
   1      2.00  105.2689   38.4319
   1      2.00  105.2689   38.4319
   1      3.00  105.2689   38.4319
   1      7.91  105.2689   38.4319
   1      1.00  105.2689   38.4319
   1      3.40  105.2689   38.4319
   1      3.00  105.2689   38.4319
   1     23.20  105.2689   38.4319
1213CANON WW      2      500.        2.  105.2253   38.4439-0.06 0.05     2
                  3   2      0.50  105.2253   38.4439
   1     19.00  105.2408   38.4376
   1      3.50  105.2408   38.4376
   1      4.68  105.2408   38.4376
1215S C POWR      4     3300.        1.0 105.2230   38.4345  .30 0.07     0
                  3   2      1.00  105.2230   38.4345
   1     37.00  105.2287   38.4403
   1     15.00  105.2287   38.4403
   1      9.00  105.2287   38.4403
1216HYD-FRUT      1     4180.       -1.8 105.1968   38.4592 0.10 0.15     2
                  1   1      0.20  105.1968   38.4592       800.
   1     77.00  105.2521   38.4348
1219OIL CK        1     1250.       -2.9 105.1885   38.4461 0.32 0.00     2
                  2   1      0.20  105.1885   38.4461       800.
   1     10.46  105.2327   38.4403
   1     14.27  105.2327   38.4403
```

```
1220FREMONT        1      425.       16.  105.1341   38.3967 0.25-0.07    2
                   4    1      0.20  105.1341   38.3967      800.
   1      17.00  105.1867   38.4272
   1       0.24  105.1867   38.4272
   1       0.28  105.1867   38.4272
   1       0.41  105.1867   38.4272
1222CF&I           3    41000.        1.  104.6250   38.2333 0.40-0.12    0
                   9    2      0.83  104.6250   38.2333
   1       2.00  105.1581   38.4145
   1      48.00  105.1581   38.4145
   1      20.00  105.1581   38.4145
   1       5.70  105.1581   38.4145
   1       1.64  105.1581   38.4145
   1     150.00  105.1581   38.4145
   1       0.    104.678    38.241
   3       150.  104.678    38.241             824
   3       -.01  105.1581   38.4145            993
1225UNION          1     1250.        2.  105.1092   38.3934 0.15-0.13    2
                   1    1      0.50  105.1092   38.3934      800.
   1      48.00  105.1583   38.4144
1228HNNKRATT       1      125.       2.0  105.1238   38.4111 0.0  0.02    2
                   5    1      0.50  105.1238   38.4111      800.
   1       1.60  105.1480   38.4140
   1       1.00  105.1480   38.4140
   1       0.56  105.1480   38.4140
   1       1.00  105.1480   38.4140
   1       1.00  105.1480   38.4140
1231L ATTRBY       1      180.       2.2  105.0580   38.4029-0.05-0.03    2
                   3    1      0.50  105.0580   38.4029      800.
   1       3.50  105.0719   38.3921
   1       2.00  105.0719   38.3921
   1       3.60  105.0719   38.3921
1234IDEAL CM       3     1600.        1.  105.0078   38.3778-0.10 0.07    0
                   7    2      1.00  105.0078   38.3778
   1       1.05  105.0147   38.3877
   1       0.50  105.0147   38.3877
   1       1.50  105.0147   38.3877
   1       1.00  105.0147   38.3877
   1       2.00  105.0147   38.3877
   1      11.50  105.0147   38.3877
   1       3.50  105.0147   38.3877
```

```
1401BESSEMER      1    20000.       1.1  104.5985   38.2296 .05 -0.16     7
                 15    1      0.20  104.5985   38.2296     1900.
   1      2.00  104.7263   38.2606
   1     20.00  104.7263   38.2606
   1      3.74  104.7263   38.2606
   1      3.00  104.7263   38.2606
   1      2.50  104.7263   38.2606
   1      5.13  104.7263   38.2606
   1      4.87  104.7263   38.2606
   1      2.00  104.7263   38.2606
   1      3.00  104.7263   38.2606
   1     14.00  104.7263   38.2606
   1      2.00  104.7263   38.2606
   1      8.00  104.7263   38.2606
   1    322.00  104.7263   38.2606
   3     -.210  104.7263   38.2606            993    2
   3      -.07  104.7263   38.2606            993
1402ST CHRLS      2        50.       2.  104.5250   38.2118 0.21-0.12     0
                  3    2      0.50  104.5250   38.2118
   1      1.01  104.6025   38.2534
      1.   1.   1.   1.   0.   0.   0.   0.   0.   0.   1.   1.
   1      0.    104.6025   38.2534
   3      -.01  104.6025   38.2534            993
1404HAMP-BEL      1        40.       2.  104.6954   38.2548 0.05 0.13     7
                  3    1      0.50  104.6954   38.2548
   1      1.03  104.7184   38.2705
   1      0.29  104.7184   38.2705
   1      1.60  104.7184   38.2705
1407W PUEBLO      1      500.       1.7  104.6519   38.2759  .05 0.04     7
                  5    1      0.50  104.6519   38.2759    1002.
   1      1.20  104.7116   38.2716
   1      1.00  104.7116   38.2716
   1      0.60  104.7116   38.2716
   1     15.00  104.7116   38.2716
   3     -.014  104.7116   38.2716            993    2
1410PUEBL WW      2     4700.       1.  104.6544   38.2740 0.27 0.03     7
                 11    2      0.50  104.6544   38.2740
   1      7.00  104.6701   38.2706
   1      8.00  104.6701   38.2706                   1
      0.   0.   0.   0.   0.   1.   1.   1.   0.   0.   0.   0.
   1      2.50  104.6701   38.2706
   1      2.20  104.6701   38.2706
   1      1.60  104.6701   38.2706                   1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   0.   0.
   1      4.60  104.6701   38.2706
   1     45.00  104.6701   38.2706
   1      2.00  104.6701   38.2706
   1      2.46  104.6701   38.2706                   1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   0.   0.
   1      7.00  104.6701   38.2706
   3    850.    104.6701   38.2706            869
```

```
1416RVRSD DY      1       55.        2.  104.6407   38.2660-0.10-0.09     7
                  1    1      0.50  104.6407   38.2660
   1      1.00   104.6552   38.2686
1419BTH-ORCH      1     1451.        3.4  104.5000   38.2691 -.05  .05     7
                  1    1      0.50  104.5000   38.2691      1260.
   2      5.     104.5      38.2691 1548.
1422EXCLSIOR      1     1583.        3.3  104.3916   38.2683-0.02 0.11     7
                  3    1      0.80  104.3916   38.2683      2726.
   1     20.00   104.4988   38.2601
   1     40.00   104.4988   38.2601
   2     52.     104.3916   38.2683 3173.
1425COLLIER       1     1000.        0.8  104.2895   38.2338  .20 -.12     3
                  3    1      0.80  104.2895   38.2338      1086.
   1      4.00   104.3458   38.2426
   1     22.00   104.3458   38.2426
   2     3.      104.2895   38.2338 1253.
1428COLORADO      1    50800.       -1.1  104.1283   38.2128  .05  .07     3
                  6    1      0.70  104.1283   38.2128      4800.
   6    756.28   104.3106   38.2453          1107    1    1
      0.   0.    0.   1.   1.   1.   1.   1.   1.   1.   0.
   2    40.      104.1283   38.2128 1800.
   3  15000.     104.3106   38.2453           854
  -3    600.     103.658    38.172           1107
  -3   2000.     103.684    38.224           1106
   2    45       104.1283   38.2128          1800
   3      -.15   104.3106   38.2453           993
1431HIGHLINE      1    24100.        1.3  104.05      37.9855 0.27-0.05     3
                 10    4      0.25  103.99     38.08        4500.
   1     40.00   104.2392   38.2269
   1      0.60   104.2392   38.2269
   1     16.00   104.2392   38.2269
   1     32.50   104.2392   38.2269
   1     32.00   104.2392   38.2269                    1
      0.   0.    0.   0.   1.   1.   1.   1.   1.   1.   0.   0.
   1    380.50   104.2392   38.2269
   3     -.282   104.2392   38.2269           993    2
   3    3200.    104.2392   38.2269           824
   2    100.     103.7651   37.9855 5644.
   3      -.07   104.2392   38.2269           993
1434OXFD-FRM      1     6000.        1.4  103.9857   38.1127 0.27-0.06     3
                  5    1      0.60  103.9857   38.1127      1800.
   1     13.40   104.1573   38.1819
   1    116.00   104.1573   38.1819
   2    50.      103.9857   38.1127 3179.
   3     -.068   104.1573   38.1819           993    2
   3      -.02   104.1573   38.1819           993
1701OTERO         1    10000.        0.7  103.5119   37.9684 0.01-0.08     8
                  5    1      0.80  103.5119   37.9684      1608.
   1    123.00   104.00     38.1416
   1    334.92   104.00     38.1416
   2    34.      103.5119   37.9684 1234.
   3     -.023   104.00     38.1416           993    2
   3      -.01   104.00     38.1416           993
```

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1703BLDWN-ST      1      650.        2.  103.9140   38.1575-0.03 -.05    8
                  1    1      0.80  103.9140   38.1575
   1     22.00  103.9738   38.1387
1704CATLIN        1    18800.        1.5  103.6294   37.9623 0.16-0.14    8
                  6    1      0.30  103.6294   37.9623     4800.
   1     22.00  103.9460   38.1273
   1    226.00  103.9460   38.1273
   1     97.00  103.9460   38.1273
   3     -.310  103.9460   38.1273            993    2
   2     63.    103.6294   37.9623 5300.
   3      -.08  103.9460   38.1273            993
1707HOLBROOK      1    19550.       -1.5  103.3980   38.0939-0.05 -.02    8
                  6    1      0.50  103.3980   38.0939     1122.
   6    155.00  103.8444   38.1212           1202    1    1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   1.   0.
   6    445.00  103.8444   38.1212           1202    1    1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   1.   0.
  -3   20000.   103.661    38.045            1202
  -3   20000.   103.580    38.029            1203
   2    50.     103.3980   38.0939 1032.
   3      -.13  103.8444   38.1212            993
1710RCKY FRD      1     8200.       -1.5  103.6746   38.0033 0.21-0.13    8
                  3    1      0.30  103.6746   38.0033     1900.
   1    111.76  103.8264   38.1124
   1     96.54  103.8264   38.1124
   2    60.     103.6746   38.0033 2200.
1716FT LYON      1    91300.       -1.3  102.6500   38.2450-0.06 0.06    6
                  7    5      0.30  102.6500   38.2450     4500.
   6    164.64  103.5878   38.0110           1238    1    1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   1.   0.
   6    597.16  103.5878   38.0110           1238    1    1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   1.   0.
   6    171.20  103.5878   38.0110           1238    1    1
      0.   0.   0.   1.   1.   1.   1.   1.   1.   1.   1.   0.
  -3    20000.  103.372    38.144            1236
  -3    20000.  103.231    38.236            1238
   2    350.    102.6500   38.2450 4500.
   3      -.22  103.5878   38.0110            993
1719LAS ANMS      1     4650.        1.8  103.2336   38.0288 0.01-0.10    6
                  7    1      0.40  103.20     38.04       4800.
   1     22.00  103.3546   38.0566
   1      5.50  103.3546   38.0566
   1     22.00  103.3546   38.0566
   1     80.00  103.3546   38.0566
   1     44.80  103.3546   38.0566
   2    60.     103.20     38.04   5200.
   3     -.093  103.3546   38.0566            993    2
```

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6701KEESEE         1     1900.       0.9  102.7470   38.0864 0.22-0.09    6
                   5    1       0.50  102.6       38.0864      840.
   3       -.01  102.8396   38.0761             1300
   1       9.00  102.8396   38.0761
   1       4.50  102.8396   38.0761
   1      15.00  102.8396   38.0761
   2      15.    102.7470   38.0864 1342.
6704FT BENT        1     6840.       1.1  102.71      38.0550 0.15-0.12    6
                   7    1       0.50  102.6       38.0550     2776.
   3       -.08  102.8394   38.0761             1300
   1      27.77  102.8394   38.0761
   1      32.77  102.8394   38.0761
   1      26.77  102.8394   38.0761
   1      50.00  102.8394   38.0761
   1      80.00  102.8394   38.0761
   2      41.    102.5591   38.0550 2250.
6707AMITY          1    37800.       1.2  102.0445   38.1303  .15 0.08    5
                   5    1       0.35  102.0445   38.1303     5500.
   3       -.35  102.7588   38.0908             1300
   1     283.50  102.7588   38.0908
   1     500.00  102.7588   38.0908
  -3     20000.  102.707    38.308              1221
   2     200.    102.0445   38.1303 7498.
6710LAMAR          1     8700.      -1.5  102.3545   38.0427 0.15-0.18    5
                   8    1       0.50  102.3545   38.0427     1937.
   3       -.11  102.6430   38.1049             1300
   1      15.75  102.6430   38.1049
   1      72.09  102.6430   38.1049
   1      13.64  102.6430   38.1049
   1      11.70  102.6430   38.1049
   1     184.27  102.6430   38.1049
   2     27.     102.3545   38.0427 1728.
   3       -.02  102.6430   38.1049              993
6713HYDE           1      970.       1.0  102.5600   38.1138 0.07 0.04    5
                   3    1       0.50  102.5600   38.1138     1620.
   3       -.01  102.6115   38.1055             1300
   1      23.44  102.6115   38.1055
   2      50.    102.5600   38.1138 1039.
6716MANVEL         1      750.       2.1  102.3431   38.0573 0.15-0.12    4
                   3    1       0.50  102.3431   38.0573     3125.
   3       -.02  102.4942   38.0948             1300
   1      54.00  102.4942   38.0948
   2     145.    102.3431   38.0573 2412.
6719X-Y GRHM       1     6000.       0.5  102.2436   38.0397 0.0 -0.15    4
                   3    1       0.50  102.2436   38.0397     2782.
   1       0.    102.4252   38.1005
   1       0.    102.4252   38.1005
   2      80.    102.2436   38.0397 3054.
```

Attachment H--*Basin water-user file for model calibration, 1975-85*--Continued

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6722BUFFALO       1     5000.       1.1  102.1372   38.0646 0.25 0.05    4
                  3    1       0.50  102.1372   38.0646     1759.
   3      -.02  102.3284   38.1005            1300
   1     67.50  102.3284   38.1005
   2     25.    102.1372   38.0646  864.
6725SSN-STUB      1      300.        2.  102.1670   38.0302-0.10-0.08    4
                  4    1       0.80  102.1670   38.0302      442.
   1      0.    102.2181   38.0468
   1      0.    102.2181   38.0468
   1      0.    102.2181   38.0468
   2     57.    102.1670   38.0302  860.
  99KANSAS        1   30000.        3.     102.01      38.05-0.10 0.05    4
                  1    3        0.00
   3      -.50  102.01      38.05             1300
 824TURQUOIS      5     27400.       1.  106.3739   39.2528  .30  .05         2
                  2    3
   5   5000.    106.3739   39.2528
   4  17500.    106.80      39.20
 825FRY-ARK1      5    129000.       1.  106.3739   39.2528  .30  .11
                  1    3
   4  57000.    106.8000   39.1000
 854TWIN LKS      5     55000.       1.  106.3125   39.0807  .45 -.10
                  3    3
   5    1000.   106.3125   39.0807
   5    1000.   106.3125   39.0807
   4  55000.    106.90      39.15
 855FRY-ARK2      5     12833.       1.  106.3125   39.0807  .45 -.04         2
                  1    3
   3  12833.    106.3739   39.2528             824    1    1
     .05   .05  .05   .05   .05   .05  .05   .05   .05  .05  .05  .05
 869CLR CK R      5     11440.       1.  106.2444   38.99     .45 -.10
                  5    3
   5     45.    106.27      38.99
   5     25.    106.27      38.99
   4    9402.   106.6       39.25
   4    9402.   106.61      39.26
   4    9402.   106.59      39.24
1106LK HENRY      5     10300.       1.  103.684    38.224   .20  .06    0
                  2    3
   5     20.    104.3106   38.2453
   5     10.    104.3106   38.2453
1107MEREDITH      5     26028.       1.  103.658    38.172  -.06  .04    0
                  1    3
   5    250.    104.3106   38.2453
1202DYE RES       5      7986.       1.  103.661    38.045   .26 -.30
                  2    3
   5    100.    103.8444   38.1212
   5    100.    103.8444   38.1212
1203HLBROK R      5      7472.       1.  103.580    38.029  -.02 -.25
                  2    3
   5    100.    103.8444   38.1212
   5    100.    103.8444   38.1212
```

Attachment H--*Basin water-user file for model calibration, 1975-85*--Continued

```
1221GR PLAIN      5   125000.         1.  102.707    38.308   .20  .04
                  1    3
   5    400.    103.5878   38.0110
1236HRS CK R      5    28000.         1.  103.372    38.144   0.0  .20
                  2    3
   5    250.    103.8444   38.1212
   5    125.    103.8444   38.1212
1238ADB CK R      5    85000.         1.  103.231    38.236  -.06  .07
                  2    3
   5    500.    103.8444   38.1212
   5    250.    103.8444   38.1212
1300JM RES        5   600000.         1.  102.92     38.07    .17  .05
                  1    3
   5  20000.    102.9369   38.0681
 993FRY-ARK3      5   264000.         1.  104.65     38.25    .30 -.20
                  3    3
   5  20000.    104.725    38.2708
   3 264000.    104.725    38.2708              854    2    1
      .03  .04  .06  .08  0.0  0.0  0.0  0.0  0.0  .02  .02  .03
   3 264000.    104.725    38.2708              824    1    1
      .03  .04  .06  .08  0.0  0.0  0.0  0.0  0.0  .02  .02  .03
9993WINTER W      5    85000.         1.  104.65     38.25    .30 -.30          2
                  1    3
   5    250.  104.65     38.25                            1
      1.   1.   1.   0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  1.
9994DUMP WW       2    85000.         1.  104.65     38.25    .30 -.40     0
                  1    2       1.00  104.725   38.27
  -3    85000.  104.7263   38.2606              993    2    1
      0.   0.   0.   0.   0.   0.   0.   0.   .3   .5   1.   0.
9107WINTER M      5     5400.         1.  103.658    38.172  -.06  .10     0
                  0    3
9202WINTER D      5    13000.         1.  103.661    38.045   .26 -.36
                  0    3
9238WINTER A      5    10000.         1.  103.231    38.236  -.06  .13
                  0    3
 999FONT VLY      2     3000.         2.    104.65     38.25-0.10 0.0           3
                  1    3      0.00
   3      -.22  104.725    38.2708              993
 998ARK VALY      2     3000.         2.    102.35     38.01-0.10 0.0           3
                  1    3      0.00
   3      -.02  102.643    38.1049              993
```


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